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ENVIRONMENTAL FOCUS SERIES: THE MEXICAN MARKET

Final Report

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EXECUTIVE SUMMARY

Despite the economic setbacks of late 1994, Mexico's environmental markets are expected to grow due to the severity of the country's environmental problems, increased attention to these problems, and fundamental structural changes in the Mexican economy. The market for water pollution control equipment and services is currently the largest market segment and is expected to continue to represent approximately 40% of the total environmental market. Generally, the fastest growing markets are expected to be in water pollution control and solid and hazardous waste, which are both projected to grow at an average annual rate of 24% per year between 1994 and 1996. Rapid growth from a small base is also projected for energy efficiency and environmental remediation services. The projected performance by market segment is shown in the table below.

Projected Performance of Mexican Environmental Markets, ($millions) 1994-1996

Market	1994	1995	1996	Avg. Annual Growth 1994-1996 (%)
Water Pollution Control*	841	1,085	1,288	24%
Solid and Hazardous Waste*	261	324	402	24%
Energy Efficiency	270	323	386	20%
Renewable Energy	149	657	699	116%
Fixed-Source Air Pollution Control	360	400	456	13%
Environmental Consulting	18	20	29	13%
Remediation	21	24	29	18%
Total	**1,919**	**2,833**	**3,282**	**21%****

* Figures exclude selected large projects which could mask underlying trends
** Excludes renewables

Environmental degradation in Mexico continues to worsen, especially in the contamination of watersheds, increased air pollution in the large cities, and water and solid waste pollution in the border areas. In response, considerable attention is being devoted to addressing Mexico's environmental problems. Numerous parties have placed environmental issues high on their agendas, including the Government of Mexico, the United States Government (as signatory to

the North American Free Trade Agreement (NAFTA)), the multilateral development banks and private industry. Public awareness and increased media attention, important precursors to environmental market development, are also on the rise.

Over the last two years, the Mexican Government has launched several new environmental initiatives, increased its monitoring and inspection, and in general stepped up its enforcement activities. Private industry, especially large and visible companies, have been forced to increase environmental expenditures. Municipalities, when unable to pay themselves, have increasingly turned to private industry to build and operate wastewater and solid waste facilities. As a result of better cost-recovery through higher tariffs, the private sector has responded with interest to these new business opportunities.

The United States Government has encouraged, and in some instances demanded, that Mexico take action with regard to its environmental problems, particularly in the border regions. The inclusion of environmental side agreements to NAFTA are the most notable of these efforts. Through the creation and initial capitalization of the North American Development Bank (NADBank), funding for environmental improvements has been assured. Since 1991 the World Bank and the Inter-American Development Bank have committed $2 billion in loans for infrastructure investment as well as for strengthening government regulatory agencies and improving management capabilities in municipalities. An additional $2 billion is in the approval process. Conditions included in the multilateral development bank loans are expected to improve the attractiveness of the environmental market for private companies.

On balance, current economic conditions favor increased growth in environmental markets for the latter half of the 1990s. While recent economic and political events have had a negative effect on the future prospects for business overall, the environmental business segment is not expected to fare any worse than the economy as a whole. The devaluation of the peso is expected to have a negative impact on the level of U.S. imports of environmental goods and services during at least 1995, but this could be counterbalanced by enhancing the competitiveness of Mexican firms, thereby increasing their profitability and ability to pay for environmental improvements. A devalued peso makes local manufacturing a more attractive business opportunity. The recent lack of investor confidence is expected to temporarily dampen the availability of funds. Long-term fundamental structural changes such as market liberalization, the privatization of state-owned enterprises, and accelerated urbanization and industrialization will continue to support a positive outlook for growth. It is not expected that the new Zedillo Administration will alter any of these fundamental structural changes. However, this does not mean that U.S. and Mexican companies entering environmental markets or considering expansions will not have to alter their business strategies to accommodate the rapidly changing economic conditions.

The largest environmental market in Mexico is for water pollution control equipment and services, which could reach $1.3 billion in 1996. The private sector market for industrial

wastewater treatment plants is expected to be the largest segment of this market, followed by government-funded municipal wastewater treatment and build-operate-transfer (BOT) projects for municipal wastewater treatment, respectively. This market is driven primarily by the increased enforcement of water pollution control regulations, including water use and discharge tariffs, and the growing demand for clean water for municipal and industrial use.

Renewable energy is projected to be the second-largest market, reaching approximately $700 million by 1996. Key components of this market include large-scale hydropower projects, geothermal expansion, and wind and solar projects. Mexico has one of the most aggressive rural solar lighting programs in the world. In addition, the national electric utility, the Comisión Federal de Electricidad, has incorporated geothermal resources into its capacity expansion plan.

Following closely behind renewable energy are the 1996 forecasts for fixed-source air pollution control equipment and services ($456 million), solid and hazardous waste equipment and services ($402 million), and energy efficiency equipment and services ($386 million). Mexico's needs for solid waste infrastructure are huge, and there has been a large growth in the involvement of private contractors in municipal refuse management. The Mexican Government has placed an emphasis on fuel switching and fuel oil desulfurization, causing the growth of retrofits. Cogeneration projects are expected to be the main driving force in the energy efficiency equipment market, followed by higher electricity tariffs.

The environmental consulting (including environmental audits and impact assessments) and environmental remediation markets are expected to achieve annual growth rates of 13% and 18%, respectively, by 1996. Although their growth is projected to be somewhat slower than the other markets, there is a positive outlook for the consulting and remediation markets due to the gradual increase in the enforcement of national and local environmental regulations.

The availability of financing remains a major determinant of the success of environmental and energy projects in Mexico. Key developments in the banking and securities markets have moderately increased the availability of short-term credits and longer-term investment capital. Additionally, traditional financial intermediaries, such as the Export-Import Bank of the United States and the Mexican development banks NAFINSA and BANOBRAS, are becoming more active in environmental lending. New bilateral and local sources of financing for environmental projects, including the NADBank, the North American Environmental Fund, and the Fideicomiso Jalisco, also contribute to making the potential for growth in Mexico's environmental markets a reality.

FOREWORD

This first edition of the *Environmental Focus Series* updates the 1992 report, *Energy and Environment Market Conditions in Mexico*, of the U.S. Agency for International Development (USAID) It was prepared by RCG/Hagler Bailly, Inc. under contract to the USAID Office of Energy, Environment, and Technology (USAID/G/ENV/EET) of the Center for Environment, Bureau for Global Programs, Field Support, and Research. Research and analysis for Chapters 2-8, the market subsector analyses, were conducted by Joseph Newman of Sierra International, LLC (Washington, DC) under contract to Hagler Bailly. Appendix B: "Profile of Environmental and Energy Markets in the U.S.-Mexico Border Region," was completed by Pati Jacobs of Market Strategies International (Austin, Texas), also under contract to Hagler Bailly.

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The *Environmental Focus Series* includes reports on promising environmental and energy markets in developing countries. Reports are of varying length and content and may be regional, country-specific, or focused on a particular market segment. To obtain more information about *Environmental Focus Series* reports, please contact the USAID Global Bureau's Office of Energy, Environment, and Technology at (703) 875-4203.

ACRONYMS AND ABBREVIATIONS

AMPIP	Mexican Association of Industrial Parks
ANDSA	a system of state-owned grain warehouses
BANCOMEXT	Mexico's official trade development bank
BANOBRAS	Mexico's official infrastructure development bank
BECC	Border Environment Cooperation Commission
BOD	biological oxygen demand
BLT	build-lease-transfer
BOT	build-operate-transfer
CEC	Commission on Environmental Cooperation
CETES	28-day treasury rates
CFE	Federal Electrical Commission
CFC	chlorofluorcarbon
CNDM	National Center for Municipal Development
COD	chemical oxygen demand
CONAE	National Commission for Energy Savings
CNA	National Water Commission
CNMD	National Commission of Municipal Development
DDF	Department of Federal District
D.F.	Federal District
DOC	U.S. Department of Commerce
EIA	environmental impact assessment
ESCO	energy services company
Ex-Im Bank	The Export-Import Bank of the United States
FIDE	Trust Fund for Support of the Energy Savings Program of CFE
FNM	the state-owned railway company
GDP	gross domestic product
GEF	Global Environment Facility
GW	gigawatt
IBWC	International Boundary and Water Commission
IDB	Inter-American Development Bank
IFC	International Finance Corporation
IIC	Inter-American Investment Corporation
IMSS	Mexican Institute for Social Security
INE	National Institute of Ecology
INEGI	National Statistical Institute
INFONAVIT	Institute for the Promotion of Worker Housing
Jexim	Japan Export-Import Bank
kWh	kilowatt hour

MAL	maximum allowable limit
MSW	municipal solid waste
MW	Megawatt
NADBank	North American Development Bank
NAEF	North American Environmental Fund
NAFINSA	a Mexican national development bank
NAFTA	North American Free Trade Agreement
NGO	non-government organization
NOMs	technical environmental standards
O&M	operations and maintenance
OECD	Organization for Economic Cooperation and Development
PECE	Pact for Stability, Competitiveness and Employment
PEMEX	National Oil Company
PM	particulate matter
PROCERA	National Program for Cooperation on Renewable Energy
PROFEPA	Office of the Attorney General for Protection of the Environment
PRONASOL	National Solidarity Program
SARH	Secretariat of Agriculture and Water Resources
SCT	Secretary of Communications and Transportation
SECOFI	Secretariat of Commerce and Industrial Development
SEDESOL	Secretariat of Social Development
SEDUE	Ministry of Urban Development and Ecology
SEMIP	Secretariat of Energy, Mines, and Parastatal Industry
SEPESCA	Secretariat of Fisheries
SHyCP	Secretariat of the Treasury and Public Credit
SIMEPRODE	Metropolitan System for the Processing of Solid Wastes
SOE	state-owned enterprise
SRE	Secretariat of Foreign Relations
SRF	state revolving fund
SSA	Secretariat of Health
STyPS	Secretariat of Labor and Social Security
TDA	U.S. Trade and Development Agency
TELEMEX	Mexico's national telephone utility
TSS	total suspended solids
UCEE	Credit Union for Energy Efficiency
USAID	U.S. Agency for International Development
USDOC	U.S. Department of Commerce
U.S. EPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

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CHAPTER 1
MARKET OVERVIEW

The 1992 USAID report *Environmental Market Conditions and Business Opportunities in Key Latin American Countries* states, "The Mexican environmental market is expected to increase nearly four-fold during the 1990s." The report asserted that this explosive growth would be driven by four key factors:

- market liberalization and increased private sector investment
- severe pollution problems caused by urbanization and industrialization
- improved enforcement of strict environmental regulations
- public pressures on the Government of Mexico to deal with environmental problems in major cities.

This chapter presents a comparision of the predictions made in the 1992 report with actual developments during the 1992-1994 period for each of these four key market drivers and offers a revised forecast. Overall, the events of 1992-1994 period reveal that the growth in Mexico's environmental markets was not as rapid as predicted in 1992; nonetheless, a solid foundation has been laid for positive growth in environmental markets in Mexico over the next two years.

1.1 MARKET LIBERALIZATION AND INCREASED PRIVATE SECTOR INVESTMENT

1992-1994 Developments

In the last two years of his administration, President Salinas implemented a number of significant market liberalization measures that will directly affect the future growth of the Mexican environmental market. These measures include the ratification of the North American Free Trade Agreement (NAFTA), inflation and exchange rate stabilization, and the privatization of state-owned companies; such structural changes are expected to improve the long-term viability of the Mexican economy.

Key Market Driver	1992 Prediction*	Current Forecast
Market liberalization and increased private sector investment	Increase in the availability of resources for environmental investments	Economic recession in 1992-1993 left many companies with fewer resources to invest in environmental projects; the net long-term impact of liberalization, however, will be positive

* 1992 predictions from USAID, *Energy and Environmental Market Conditions in Mexico*. Arlington, VA: USAID, 1992.

The 1992-1993 period, however, saw a sharp contraction in economic growth, which temporarily overshadowed potential long-term gains and left Mexican companies with fewer resources to invest in environmental and energy projects. The 1992-1993 economic recession was primarily the result of three factors: tight fiscal and monetary policies which kept nominal interest rates in the 15-20% range, exposure to international competition through NAFTA, and slowed growth in the United States and the economies of Mexico's other major trading partners.[1] Consequently, Mexico's GDP growth slowed from 2.8% in 1992 to 0.4% in 1993. GDP growth is expected to pick up again to around 1.8% by the end of 1994.[2]

While Mexican companies in all sectors have faced the challenge of adjusting to international competition in a slow growth economy, some sectors have fared better than others. Manufacturing was hit hardest by the recession, while services and construction posted positive growth rates (Exhibit 1-1). Within manufacturing, the subsectors most severely affected were the textiles, wood products and paper industries.

Despite the short-term setbacks of the 1992-1993 economic recession, the net impact of market liberalization on the Mexican environmental market is expected to be positive. The NAFTA tariff reductions, for example, have already increased the cross-border trade of environmental goods and services. Tariffs on nearly all categories of environmental equipment will be eliminated by 1998. Appendix A contains the 1994 NAFTA Mexican tariff schedule for selected categories of pollution control equipment. In total, the U.S. Department of Commerce estimates that NAFTA will increase exports of environmental equipment to Mexico and U.S. environmental jobs by 20%-50% annually through the year 2000 (Exhibit 1-2).

1 U.S. Embassy Mexico, *Mexico Economic and Financial Report - Winter 1994.*

2 Grupo Financiero Bancomer, *The Mexican Economy: Monthly Evaluation and Forecast*, July 1994.

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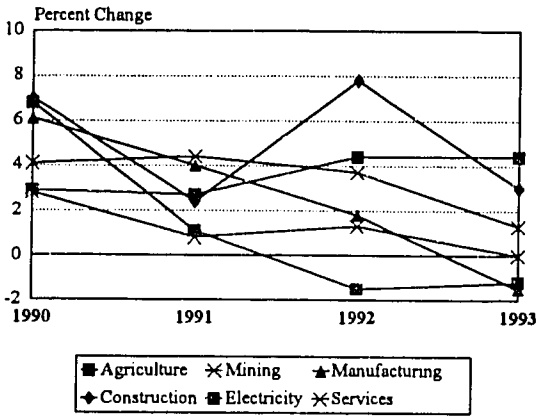
Exhibit 1-1
Mexican GDP Growth by Sector (1990-1993)

Mexican GDP Growth by Sector (1990-1993)



Growth in Selected Mexican Manufacturing Industries (1990-1993)

	1990	*1991*	*1992*	*1993*
Food, beverages, tobacco	3.1	5.1	3.7	2.2
Textiles and clothing	2.9	-3.7	-5.0	-8.4
Wood, wood products	-1.1	0.6	-2.0	-8.6
Paper, printing	4.4	-1.3	-1.6	-3.7
Chemical, rubber, plastics	5.2	3.0	2.2	0.1
Non-metallic minerals	6.4	3.1	7.0	2.3
Basic metals	8.1	-3.6	-0.4	4.0
Metal products, machinery	13.4	12.3	1.4	-4.2
Other manufacturing	8.9	1.9	13.1	5.1

Note: "Services" includes financial, transportation and communications, retail and hotel, and other services.
Source: U.S. Embassy, Mexico and National Statistical Institute

NAFTA and the Environmental Side Agreements

NAFTA is accompanied by two important side agreements: the NAFTA Supplemental Agreement on Environmental Cooperation and the Integrated Environmental Plan for the Mexican-U.S. Border Area. The supplemental environmental agreement, which was finalized in September 1993, outlines the obligations of each signatory with regards to the development and enforcement of environmental policy. These obligations include allowing public comment on new environmental laws and regulations, and providing private citizens with access to remedies such as civil suits and injunctions when environmental laws are violated. It also established the trilateral Commission on Environmental Cooperation (CEC) as a forum for technical information exchange. The CEC will be housed in Montreal and will be responsible for enforcing trilateral environmental dispute settlement procedures and trade sanctions in the event that a signatory violates its environmental enforcement obligations.

The Integrated Environmental Plan for the Mexican-U.S. Border Area is a program designed by SEDESOL and the U.S. EPA to tackle bilateral environmental problems in parallel with NAFTA implementation. The program plan builds on the original Border Environmental Agreement signed in 1983. The first stage (1992-1994) of the new border plan entails a total investment of over $800 million by the Mexican and U.S. Governments in municipal wastewater treatment and solid waste management infrastructure projects along the border. The plan also provides for the development of a cooperative enforcement strategy, covering joint inspector training, monitoring, and information exchange, especially for tracking cross-border shipments of hazardous waste.

Exhibit 1-2
NAFTA's Impact on U.S. Environmental Sales and Jobs
(sales in US $ billions)

Year	Export Sales with NAFTA	Export Sales without NAFTA	Jobs Increase with NAFTA	Jobs Increase without NAFTA
1994	$1.6	$1.3	37,000	29,000
1995	2.0	1.4	43,000	31,000
1996	2.4	1.5	52,000	33,000
1997	2.7	1.7	58,000	36,000
1998	3.0	1.9	61,000	38,000
1999	3.4	2.1	65,000	40,000
2000	3.8	2.3	69,500	40,000

Source: U.S. Department of Commerce, 1993

Exhibit 1-3 summarizes the impacts of NAFTA and other key liberalization measures on the Mexican environmental market. The Mexican Government's economic stabilization program under the Salinas Administration consisted of policies to lower inflation, stabilize the exchange rate, keep interest rates high to attract foreign capital, and curb public spending. On the positive side, these policies enhanced the price competitiveness of equipment imported into Mexico. Additionally, tight fiscal spending targets have compelled the Mexican Government to devolve the functions of infrastructure development and maintenance to private companies. On the negative side, high interest rates have made many Mexican companies averse to borrowing for environmental projects.

The ongoing privatization of state-owned enterprises (SOEs) is also expected to have positive impacts on the Mexican environmental market. About 200 of the original 1,155 SOEs are still to be privatized. These actions will bring an influx of private capital that can be used to invest in energy and environmental projects. Additionally, the transfer of ownership requirements may increase the demand for environmental consulting services such as site assessment and remediation.

Exhibit 1-3
Impact of Market Liberalization on the Mexican Energy and Environmental Market

Liberalization Measure	Key Provisions	Impact on Energy and Environmental Market	
		Positive	*Negative*
NAFTA (trade liberalization)	• reduced tariffs on traded goods and services, including specific categories of energy/ environmental technologies and engineering services • streamlined customs procedures • right to subject new investment to local environmental standards (including EIA requirements) • stronger intellectual property rights protection	• U.S. and Canadian equipment and services have immediate tariff advantage over those from EC and Japan • reduced time for clearing imports at the border may facilitate decision to purchase U.S. equipment • demand for EIAs and other environmental consulting services will increase	• exposure to international competition is squeezing many Mexican companies that now have fewer resources to invest in energy and environment • Mexican Government is easing environmental regulatory pressure to allow companies to adjust to competition
Inflation reduction and economic stabilization	• inflation lowered to single digits in 1993 • high interest rates (15-20%) and exchange rate stabilization • fiscal austerity through government spending targets	• enchanced competitiveness of imports to Mexican market • reduced capital flight, increased foreign investment in Mexico • focus shifted from public spending towards increasing private sector participation in infrastructure development, including major energy and environmental projects	• Mexican companies averse to borrowing at high interest rates for energy and environmental projects • Difficulties with exchange rate stabilization
Privatization of state-owned enterprises (SOEs)	• 200 SOEs (of 1,155 in 1982) left to be privatized • seafood processing and secondary petrochemicals slated for 1994	• efficiency gains and influx of private investment will mean more resources to invest in energy and environment • regulatory enforcement generally stricter for private companies • transfer of ownership may require site assessment and remediation and other environmental services	• no direct negative impacts
Pact for Stability, Competiveness and Employment (PECE) (revised 1993)	• provision to increase tax deductions permitted to amortize environmental equipment from 35% to 50%	• increased capital expenditures on pollution control and energy efficiency	• no direct negative impacts

Last, the 1993 revisions to the Government of Mexico's Pact for Stability, Competitiveness and Employment (PECE) contain provisions to increase tax deductions permitted to amortize environmental equipment from 35% to 50%. This fiscal incentive should drive additional capital expenditures on pollution control and energy efficiency.

The Outlook for 1995-1997

Mexico's overall economic growth for 1994 may not achieve the growth rates of 1991-1992 due to political uncertainty (e.g., performance of the new Zedillo Administration, the Chiapas uprising, kidnappings of key business executives) and the carry-over effects from a recovering U.S. economy. The restructuring of the economy under the Salinas Administration, futher planned liberalizations, and continuing support from the United States, Canada, and The World Bank ($2 billion in loans last year, more than any other middle-income country) are generally expected to create a positive outlook for the next few years.

However, the peso crisis of December 1994 has somewhat clouded this generally optimistic picture. The shock of a 30% devaluation of the peso and the flight of billions of dollars in capital market investment have forced President Zedillo to announce an emergency plan to stabilize the peso, prevent runaway inflation, and restore investor confidence. The immediate impact of the devaluation of the peso is that U.S. goods become more expensive in Mexico and locally manufactured goods will become more competitive. This may cause environmental companies to change their capital strategies for doing business in Mexico. Notwithstanding the recent economic downturn, the long-term fundamentals of the environmental market are still positive.

In Mexico, the public and parastatal sectors are the largest consumers of enviromental goods and services, spending primarily on state and municipal environmental water and solid waste infrastructure projects. Under NAFTA, U.S. companies are able to receive federal, parastatal, and federally-funded procurement contracts above established thresholds.[3] However, Zedillo's stablization plan includes measures to cut federal spending, which may negatively affect the growth of the public-sector buyer segment of the environmental market.

[3] North American suppliers must be allowed to participate in the bidding process on a no-less-favorable basis than Mexican suppliers. The eligibility threshold for Mexican central government agencies is $50,000 for contracts for goods and/or services and $6.5 million for construction services. For state-owned entities the threshold is $250,000 for goods and/or services and $8 million for construction services.

1.2 SEVERE POLLUTION PROBLEMS CAUSED BY URBANIZATION AND INDUSTRIALIZATION

1992-1994 Developments

The 1992 USAID report stated that severe pollution problems caused by urbanization and industrialization would drive demand for large-scale urban environmental infrastructure projects and waste recycling systems. Indeed, the demographic and industrial growth trends continue upward from the figures reported in the 1990 five-year census conducted by the National Statistical Institute (INEGI). When combined with Mexico's sensitive ecological conditions, these trends have exacerbated the deterioration of air, water and soil quality in most regions of the country. The major difference in 1994 versus 1992 is the increase in the number of visible efforts on the part of the Mexican Government to ensure that urban and industrial growth are environmentally sustainable.

Key Market Driver	1992 Prediction	Current Forecast
Severe pollution problems caused by urbanization and industrialization	Drives demand for large-scale urban environmental infrastructure projects and waste recycling systems	Demand still far exceeds supply; large cities are beginning to invest in environmental infrastructure; medium cities are mobilizing as well

Urbanization. INEGI's 1990 census counted a total population of 82 million. At a current growth rate of around 2%, the Mexican population will exceed 100 million by 2000 and approach 150 million by 2025. Over 60% of Mexico's people live in cities (Exhibit 1-4). There are four cities in Mexico with populations over one million: Mexico City (15 million), Guadalajara (2.9 million), Monterrey (2.6 million) and Puebla (1.2 million).

Exhibit 1-4
Mexico Urban/Rural Profile 1990

Classification (# of inhabitants)	% of Total Population	Number of Cities/ Communities throughout Mexico
Metropolitan Zones (> 1 million)	26.7	4
Medium Cities (100,000 - 1 million)	21.8	56
Small Cities (15,000 - 10,000)	13.0	320
Rural Communities (< 15,000)	38.5	156,184

Source: INEGI, *General Census of the Population 1990.*

Urbanization has taken place without the corresponding development of an adequate municipal wastewater and solid waste collection and treatment infrastructure. Mexico City, Guadalajara and Monterrey alone utilize 49% of the country's water resources and generate a combined total of 53 m^3/second of wastewater, but only 15% of these total discharges is treated.[4] Metropolitan Mexico City generates around 19,000 metric tons of municipal solid waste per day; by the year 2000, this is projected to reach 25,000 tons/day. In Guadalajara, solid waste generation is estimated to be 2,820 tons/day.[5] Of the country's total municipal solid waste generated, less than 5% is currently disposed of in adequate facilities.

Industrialization. INEGI's 1990 census counted 149,232 industrial facilities throughout the country. Of these, 141,446 were in the manufacturing sector and 2,442 in oil and mining (Exhibit 1-5). In manufacturing, the largest number of facilities are in the food/drink/tobacco, textile, and wood processing industries.

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[4] SEDESOL, *Informe de la Situación General en Materia de Equilibrio Ecológico y Protección al Ambiente 1991-1992*, 1993.

[5] Medina, Francisco and Alfredo Figarola, "Perspectiva Ambiental del Estado de Jalisco," *Calidad Ambiental*, No. 4, January 1994.

Exhibit 1-5
Mexico Industrial Profile

	Number of Industrial Facilities
Manufacturing (Subtotal)	141,446
— Food, Drink, Tobacco	51,151
— Textile	16,853
— Wood Processing	16,141
— Pulp and Paper	7,952
— Chemicals	5,472
Oil and Mining	2,442
Other	5,344
Total	**149,232**

Source: INEGI, *General Census of the Population 1990.*

Mexico City alone hosts 50% of the country's total industrial production. Petroleum refining is concentrated in the state of Veracruz, while manufacturing is concentrated in the other major cities (Monterrey and Guadalajara), the U.S.-Mexico border area, and newer growth corridors such as Saltillo (Coahuila) and Salamanca (Mexico State).

The Secretariat of Social Development (SEDESOL) estimates that the industrial sector generates approximately $82m^3$/second of wastewater; the most polluting industries are the sugar, chemical, pulp and paper, petroleum, food and beverage, and steel industries. The sugar industry is responsible for 39% and the chemical industry for 21% of total industrial discharges. Mexican industry, including power generation, is also responsible for 35% (110 billion kcal/day) of the country's total energy consumption.

Mexico's Sensitive Ecological Conditions. Approximately 53% of Mexico's total land mass is classified as desert, arid or semi-arid. Precipitation only occurs during the four- to six-month rainy season and is mostly concentrated in areas with low population density in the coastal regions. In fact, 82% of the country's water supply comes from sources 0-500 meters above sea level, while 76% of the total population lives over 500 meters above sea level. This means that less than one-third of total surface drainage occurs in the 75% of land where the largest population, industrial and agricultural activities are concentrated.

The resulting overexploitation of sub-surface and surface water resources has had serious consequences. In Mexico City, pumping exceeds natural recharge by 50-80%, causing falling groundwater levels, compaction of the aquifer, subsidence of the land, and damage to surface structures, including the sinking of the famous cathedral in the Central Plaza. Additionally, it is reported that saline intrusion in 11 of the country's critical watersheds is curtailing the annual grain harvest by 1 million tons, enough to feed 5 million people.

The special characteristics of the Valley of Mexico airshed also exacerbate problems brought on by urbanization and industrialization. The Valley of Mexico, which houses metropolitan Mexico City, is situated 2,273 meters above sea level and is surrounded by volcanic mountains. The high altitude means less efficient combustion of fossil fuels. Furthermore, each winter thermal inversions trap pollutants under a blanket of cool air, creating periodic air quality emergencies from November to March.

Impacts on Environmental Quality. The combination of unregulated urbanization and industrial growth has taken a severe toll on Mexico's water, soil and air quality. According to CNA's Water Quality Index (Indice de Calidad de Agua - ICA),[6] all of the country's 29 main watersheds for which there are data were considered contaminated in 1991. Of these 29, 8 were labelled "excessively contaminated" and 12 "strongly contaminated."[7] 1993 data will be published soon in the Mexican Government's 1994 annual report on the state of the environment, but it is unlikely that the new data will show that improvements have been made.[8]

Twenty of the country's 40 river basins receive 90% of Mexico's discharges, with only a small fraction being effectively treated. The largest wastewater flows are in the Lerma-Chapala-Santiago, San Juan, Balsas, Pánuco, Blanco, Nazas and Bravo river basins. These basins are receiving priority at the federal level.

Since over 95% of the solid and hazardous waste generated in Mexico is dumped in unregistered, unsecured dump sites, it is difficult to estimate the extent of damage to water and soil quality caused by leachate from these contaminated sites. Air quality, on the other hand, is closely tracked through the National Atmospheric Monitoring Network (Red Nacional de Monitoreo Atmosférico). The Mexican Government estimates that 40% of the country's air pollution is generated in the three major cities: Mexico City, Monterrey and Guadalajara.

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6 This index is based on the following parameters: BOD, COD, dissolved oxygen, pH, total suspended solids, total dissolved solids, fecal coliform, ammonia, nitrates, phosphates, chlorides, temperature, detergents and electrical conductivity.

7 Comisión Nacional de Agua, 1992.

8 The *Informe de la Situación General en Materia de Equilibrio Ecológico y Protección al Ambiente* is published annually by the Instituto Nacional de Ecología (the National Ecology Institute) of SEDESOL.

Although the transport sector is responsible for more than half of the air pollution in these cities, industrial sources (including power generation) are major contributors of SO_2, NO_x, particulates and other criteria pollutants.

Outlook for 1995-1997

Over the past few years, federal, regional, state and local activities to curb environmental deterioration have increased. These initiatives will play an important role in driving the demand for environmental equipment and services over the next few years.

The Programa de Cien Ciudades (100 Cities Program) run by the Subsecretariat of Urban and Infrastructure Development in SEDESOL is a good example. The objective of Cien Ciudades is to promote migration away from the largest metropolitan areas to 114 medium-sized cities (50,000-1,000,000 inhabitants) chosen for their economic growth potential and location. Participating cities are required to incorporate land use planning and regulation into urban management. Other activities include establishing nature reserves and the construction of wastewater treatment plants. Forty-three percent of the program is funded by the federal government, with the remainder provided by state and city governments, private funds and international financing. As of June 1994, around 30% of the participating cities had submitted municipal development plans. The Cancún-Tulum, Tijuana-Enseñada, and San José del Cabo-Cabo San Lucas corridors are viewed as important pilot cases by SEDESOL.

Highly visible regional efforts include the clean-up program for the Río Lerma-Lago Chapala Basin, and the air pollution control program for the Valley of Mexico. Some Mexican states, including Jalisco and Nuevo Leon, are also taking charge to implement their own environmental protection plans. Several of these are discussed in other chapters of this report.

1.3 IMPROVED ENFORCEMENT OF STRICT ENVIRONMENTAL REGULATIONS

1992-1994 Developments

The 1992 USAID report stated that improved enforcement of strict environmental regulations would increase demand for industrial waste treatment equipment. A review of enforcement trends during 1992-1994 indicates that the Mexican Government has indeed made substantial progress in inspections and monitoring. Enforcement, however, is still limited to certain categories of large, highly visible industries.

Key Market Driver	1992 Prediction	Current Forecast
Improved enforcement of strict environmental regulations	Will increase immediate demand for industrial waste treatment equipment	Enforcement activities have increased significantly during 1992-1994, and large firms in particular are beginning to respond; however, enforcement remains focused on the largest companies in a few key regions (Mexico City, Monterrey, Guadalajara, U.S.-Mexico border area)

Some of the most significant developments in enforcement since 1992 are discussed below.

New environmental standards are being drafted. The General Ecology Law of 1988 grants authority to the federal government to develop and enforce technical environmental standards, called *normas oficiales mexicanas* (NOMs).[9] As of May 1994, 58 NOMs covering wastewater, air emissions, air quality monitoring and hazardous waste had been published. The wastewater NOMs are specific to industry type, while the air and hazardous waste NOMs regulate point sources and generators, respectively, as in the United States.

A number of additional standards covering hazardous waste, municipal solid waste, air, wastewater, environmental risk, and soil are currently under development (Exhibit 1-6). It was the original intention of the Mexican Government to have 201 environmental NOMs by the end of 1994. However, the August 1994 presidential election and accompanying staff turnovers at SEDESOL have slowed this process considerably. Private sector observers anticipate that the majority of the new NOMs will be published by early 1995.

New regulatory agencies were created. As in the United States, there are three levels of environmental enforcement in Mexico: federal, state and local. Since 1992, there have been major changes in the enforcement structure at the federal level. Additionally, state and local agencies are beginning to take on greater enforcement responsibilities.

[9] NOMs are officially reviewed and published in the *Diario Oficial* by the Secretariat for Commerce and Industrial Development (SECOFI). Copies can be obtained directly from SECOFI's Department of Certification and Verification of Obligatory Standards, tel. 525-540-2620, fax 525-606-0386.

Exhibit 1-6
Selected New NOMs Expected by 1995

Wastewater	Solid & Hazardous Waste	Air
new industries covered: • distilleries • pigments and colorants • electroplating • edible oils • pharmaceuticals other sources: • municipal sewers and drainage • agroprocessing facilities • PEMEX sales and facilities	• siting/construction/operation of sanitary landfills for municipal solid waste (MSW) • collection/separation/transport/ disposal of hospital wastes • hazardous waste incineration • impermeable linings for controlled storage sites	• volatile organic emissions from refineries, solvent use, paint manufacturing, wood finishing, and others • hydrofluroic acid emissions from fabrication operations • hydrosulfuric acid and mercaptan emissions from cellulose recovery • particulates and sulfur dioxide emissions from non-ferrous metals processing • NOx emissions from chimneys and smokestacks

The secretariat responsible for environmental protection in Mexico has undergone several changes in the last few years. In 1992, the former Secretariat of Urban Development and Ecology (SEDUE) was dissolved and its environmental regulatory responsibilities turned over to a newly created agency, the Secretariat of Social Development (SEDESOL), which was responsible for social development initiatives and environmental protection as mandated by the General Ecology Law of 1988. SEDESOL has housed two divisions charged with environmental policy formulation and enforcement, the National Institute of Ecology (Instituto Nacional de Ecología - INE) and the Office of the Attorney General for Protection of the Environment (Procuraduría Federal de Protección al Ambiente - PROFEPA), respectively. The responsibilities of the two divisions are as follows:

INE is responsible for:

- research, formulation and evaluation of environmental policies and standards
- evaluation of environmental impact assessments (EIAs)
- increasing environmental policy expertise at the state level.

PROFEPA is responsible for:

- enforcing federal hazardous waste and air regulations (in conjunction with municipal authorities)
- inspections and administration of fines and penalties in non-compliance cases
- providing direct access for and responding to public complaints
- supporting state and local government enforcement activities.

Shortly after taking office in December 1994, President Zedillo announced the reform of various Executive Agencies[10] including the creation of a new environmental agency, the Secretariat of the Environment, Natural Resources. The environmental responsibilities of SEDESOL will be transfered to the new secretariat. Appendix A (Exhibit A-1) provides an overview of the announced reforms of the secretariats with environmental responsiblities. As the changes have not yet been implemented, this report will continue to refer to INE, PROFEFA, and SEDESOL as they are structured as of December 1994.

Enforcement of the 1992 Law of National Waters (Ley de Aguas Nacionales) is the responsibility of the National Water Commission (Comisión Nacional de Agua - CNA) and of the municipal water authorities.[11] CNA enforces regulations governing discharges to receiving bodies, while municipal water authorities regulate discharges to sewers through a local registration and permitting procedure. A major component of the national water law is the introduction of water use and discharge fees (see Chapter 2 for details). These fees comprise a substantial percentage of CNA's operating revenues and the agency is correspondingly tough on collecting them. In general, CNA and PROFEPA do not coordinate their enforcement activities. Appendix A contains organizational charts of INE, PROFEPA and CNA.

PROFEPA dramatically increased inspections yet reduced plant closures. SEDESOL increased the number of PROFEPA inspectors from 250 in 1992 to around 500 in 1993 (120 inspectors work in Mexico City alone). Furthermore, SEDESOL was to add 500 new inspectors by the end of 1994, but the status of this is not clear.

During the first nine months of 1993, PROFEPA conducted two and-a-half times as many inspections as in the whole of 1992 (Exhibit 1-7). The number of partial and total plant closures in 1993, however, did not increase in the same dramatic proportions. Instead, there was a higher proportion of "plants with minor irregularities" cited by PROFEPA in 1993 vs. 1992. This trend is most dramatic in the case of Mexico City. A number of Mexican Government officials and industry representatives assert that PROFEPA eased regulatory pressure on companies during the recession of 1993.

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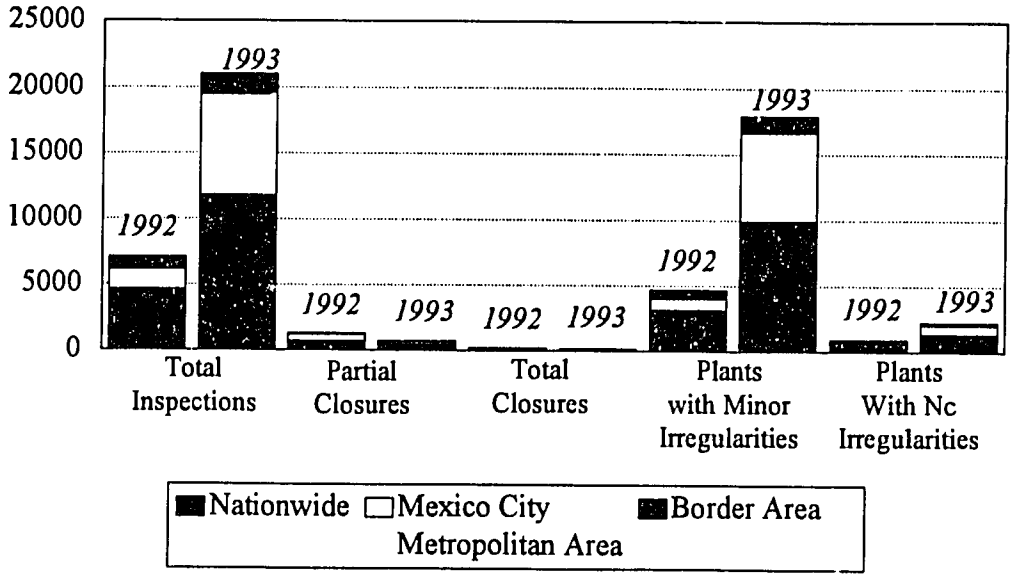
[10] These reforms were approved by the Mexican Congress on December 19, 1994.

[11] CNA has been an autonomous agency under the Secretariat of Agriculture and Hydraulic Resources, but is slated to move to the new Environmental Secretariat.

Exhibit 1-7
PROFEPA Enforcement Activities
1992-1993 (Jan. - Sept.)



Source: PROFEPA, 1993.

PROFEPA staff state that their inspectors visited over 65% of all companies in Mexico between July 1992 and July 1994. They expect to cover the remainder over the next two years. Additionally, PROFEPA has assessed around $10 million in fines, although not all of these have been collected.

PROFEPA has improved inspection procedures and post-inspection follow-up. It appears that PROFEPA's increased efforts to train its inspectors are paying off. In late 1992, PROFEPA began conducting random inspections (some by helicopter) in addition to responding to public complaints. Private sector representatives comment that complaints lead to more thorough, multi-media inspections and sometimes to plant closures.

Before 1993, most plant closures were temporary, and the plant reopened as soon as the company presented an action plan to address the violations. Now, violators are required to post a performance bond proportional to the estimated cost of installing the pollution control equipment. As of mid-November 1992, 40 bonds had been sent to the Treasury Secretariat for collection. Industry representatives also report that PROFEPA inspectors now follow up on individual cleanup agreements, while in the past there was rarely follow-up.

PROFEPA launched a voluntary industrial audit program. In September 1993, PROFEPA launched a pilot voluntary audit program for industries (mainly those of PEMEX, the national

oil company) in the Coatzacoalcos River Basin in southern Veracruz State, a zone severely damaged from the heavy concentration of petroleum refining. The audits were conducted primarily by U.S. and British environmental firms and paid for by the Mexican Government. The pilot was a success, and, as of June 1994, over 120 audits had been voluntarily conducted by companies in 24 of Mexico's 31 states and another 150 are in progress. Some companies participating to date include Grupo Cementos Mexicanos, Ferrocarriles Nacionales de México, Grupo Peñoles, General Motors, Nestle, Industrias Luismin, Grupo Azucarero México and Cementos Apasco. PEMEX itself was expected to conduct numerous audits in 1994. Participants to date have been the largest industrial companies; no medium or small-sized firms have yet participated. The latest state-owned firm to come on board as of June 1994 is the national electric utility (Comisión Nacional de Electricidad - CFE). CFE and PROFEPA are now working out a timetable for auditing all federal electricity generating plants within the next two years, beginning with five plants by the end of 1994.

The audit program is run by the Office of the Assistant Attorney General for Environmental Audits within PROFEPA. Companies are motivated to participate because they can negotiate voluntary compliance agreements with SEDESOL via the audit program and, thus, avoid inspection and potential fines. Companies can request that PROFEPA perform the audit, use a PROFEPA-recommended consulting firm, or do the audit internally.

In a similar program, PROFEPA signed the "Green Flags" Agreement in June 1993 with the Mexican Association of Industrial Parks (AMPIP). In order to receive "Green Flags" endorsement, an industrial park must undergo an environmental audit to ensure compliance with federal regulations. The park management must also ensure that their tenant industries also comply. AMPIP's membership includes the managers of 70 major development parks in Mexico.

Outlook for 1995-1997

Although PROFEPA and CNA will continue to boost their enforcement efforts, enforcement will remain focused on the largest, most visible firms in the near term. Large, foreign-owned (especially U.S.) companies in the automotive, chemicals, food and beverage, and electronics industries are likely targets. Additionally, enforcement efforts will remain concentrated in the high profile regions of Mexico City, Monterrey, Guadalajara, the U.S.-Mexico border.

1.4 PUBLIC PRESSURES ON THE GOVERNMENT TO DEAL WITH ENVIRONMENTAL PROBLEMS IN MAJOR CITIES

1992-1994 Developments

In the past two years, public pressure has become more apparent as a motivating force behind the efforts of government and industry to deal with environmental problems. This trend is manifested in three major developments: 1) the establishment of an official mechanism for public participation in PROFEPA's enforcement program; 2) growth in the number of environmental non-governmental organizations (NGOs); and 3) increased media attention given to municipal and industrial environmental issues.

Key Market Driver	1992 Prediction	Current Forecast
Public pressures on the government and industry to deal with environmental problems	Will drive the implementation of highly visible pollution control initiatives and ensure government commitment to improving enforcement, continuing new programs, and financing environmental activities	Public pressure is only now emerging as an enforcement alternative in Mexico City and the border region

Increased public participation in enforcement. In 1992, SEDESOL launched the Quejas y Denuncias (Complaints and Denouncements) program for receiving official public environmental complaints. This program is managed by La Unidad de Quejas (the Complaints Unit) within PROFEPA. An official public complaint is referred to as a *denuncia popular* (public complaint). When a *denuncia* is received by PROFEPA, it is evaluated and the alleged offenders notified. Alleged offenses deemed threatening to public health are put on an official register, and PROFEPA inspectors are sent out to the site. PROFEPA updates the person(s) who filed the *denuncia* on subsequent enforcement actions taken. In the two years the program has been active, PROFEPA has responded to around 3,000 *denuncias*; around 70% of these were related to problems in the Mexico City Metropolitan Zone and surrounding areas of Mexico State. Although some claim that the program is not well publicized yet, it nonetheless provides an important alternative enforcement mechanism for PROFEPA.

Growth in environmental NGOs. Environmental activism in the "brown" sector (i.e., municipal and industrial pollution) is a new trend in Mexico. While there are a number of Mexican NGOs focusing on wildlife and forest conservation and ecotourism, some groups are beginning to focus on brown issues. The most well-organized of these tend to be concentrated in Mexico City and the border region. In Mexico City, the Grupo de los Cien (Group of 100) is an organization of prominent artists and intellectuals focusing on tropical forest and wildlife conservation, human

rights and environmental issues in Mexico City. The group recently began to put pressure on the federal and municipal governments through the *denuncia popular* program. Also in Mexico City, Greenpeace is one of the few international environmental NGOs to have established an autonomous Mexico office. Greenpeace is currently focusing on transportation planning in Mexico City, climate change, ozone depletion, and hazardous waste tracking, and hopes to begin investigating other industrial pollution control issues in the next few years.

A number of environmental Mexican and U.S. NGOs play an important role in implementing cross-border community-based programs in hazardous waste tracking, emergency response and other issues affecting public health and safety. Some of the most active of these include the Border Ecology Project, Arizona Toxics Information, and the Red Frontera, which is a network of smaller NGOs in the border region.

Increased media attention. In the past, environmental catastrophes, such as the air pollution emergencies in Mexico City and the Guadalajara sewer explosions, received extensive but temporary media attention in Mexico. Recently, Mexican newspapers have begun to report more consistently on environmental issues, especially those related to public health and safety. The Mexico City-based newspaper *Reforma*, for example, prints a two-page daily environmental section that contains updates on air quality, solid waste dumping, and other environmental issues in Mexico City, as well as educational pieces on the health effects of certain pollutants. *Reforma* hopes to expand its environmental reporting to cover national issues as well. Another Mexico City-based paper, *The News*, also has a daily environmental column. The Monterrey-based paper *El Norte* has an environmental section that focuses more directly on cases of industrial non-compliance and major municipal environmental issues. In several cases, *El Norte* stories have inspired PROFEPA inspectors to take enforcement action against alleged violators.

Outlook for 1995-1997

As these mechanisms for channeling public pressure become more well established, municipalities and industry will come under more pressure to invest in environmental projects. Major trends expected to develop in 1995-1997 include increased involvement of local neighborhood associations in filing *denuncias*, greater involvement on the part of environmental NGOs in "brown" issues, and more attention given to environmental issues on a daily basis in the print media.

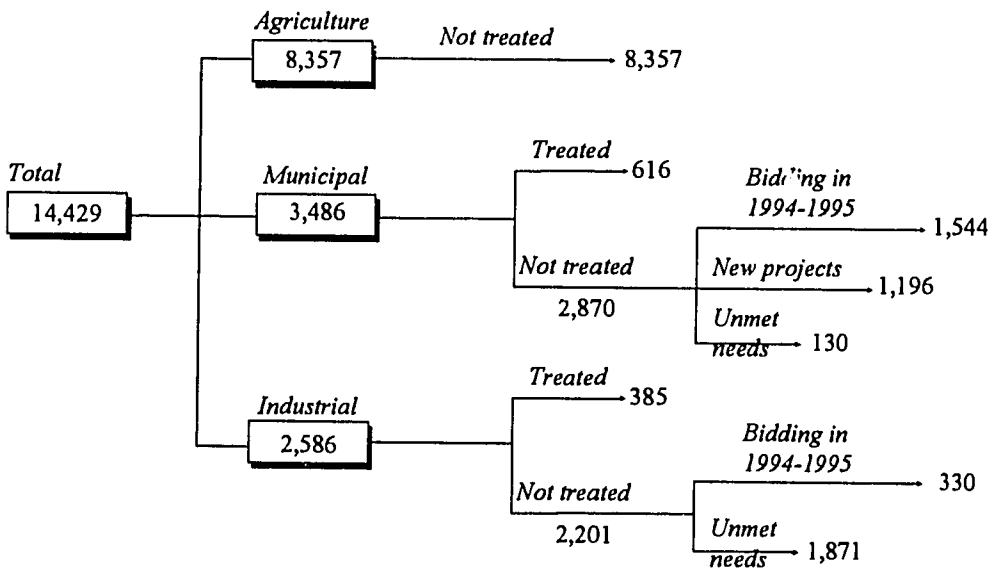
CHAPTER 2
WATER POLLUTION CONTROL

Key Market Segments

Municipal Wastewater Treatment
Industrial Wastewater Treatment

Mexico generates almost 14,500 million cubic meters of wastewater each year (Exhibit 2-1). The agriculture sector accounts for 58% of the total discharges, while the municipal and industrial sectors are responsible for 24% and 18%, respectiveiy. In 1994, only 18% of the total municipal discharges and 15% of the total industrial discharges were treated.

Exhibit 2-1
Estimated Wastewater Generation in Mexico 1994
(million cubic meters per year)



Source: Instituto Tecnológico y de Estudios Superiores de Monterrey/CNA.

Water quality experts at the Instituto Tecnológico y de Estudios Superiores de Monterrey (the Technical Institute of Monterrey) and the Comisión Nacional de Agua (the Mexican Government's National Water Commission, which is responsible for regulating water supply and municipal and industrial discharges throughout Mexico) estimate that the wastewater treatment plants scheduled for construction during 1994-1995 will be able to treat all but 4% of Mexico's municipal wastewater. However, despite the new projects planned for the industrial sector, 72% of total industrial discharges will remain untreated in 1996.

2.1 MARKET ESTIMATES

Taking into account Mexico's approximate discharge volumes, the market for water pollution control equipment and services in Mexico is estimated to be $1.09 billion in 1995 and $1.29 billion in 1996 (Exhibit 2-2). Excluding PEMEX's (the national oil company) build-operate-transfer (BOT) wastewater treatment projects, which will be privately constructed and operated, this market is expected to grow at 19% during 1995-1996.

Exhibit 2-2
Water Pollution Control Market Estimates
(millions of US$)

Segment	1993	1994	1995	1996	Avg Growth 1993 to 1996
Municipal					
Instrumentation*	39.0	45.0	52.0	61.0	16%
BOTs	160.0	200.0	240.0	287.0	22%
O&M/Distribution Contracts*	40.0	50.0	65.0	85.0	29%
Multilateral Funded	80.0	80.0	160.0	195.0	41%
Traditional Govt Funded	300.0	200.0	260.0	300.0	4%
Industrial					
Instrumentation*	30.0	36.0	43.0	52.0	20%
PEMEX BOTs	0.0	250.0	0.0	150.0	N/A
Wastewater Treatment	200.0	230.0	265.0	308.0	15%
TOTALS	848.0	1,091.0	1,085.0	1,438.0	20%
TOTALS Minus PEMEX	848.0	841.0	1,085.0	1,288.0	16%

* Not including $1 billion in Mexico City water distribution concessions awarded in 1994.
** Not including PEMEX BOT projects.

The largest segment of this market will be the private sector market for industrial wastewater treatment plants, which is expected to reach $308 million in 1996. The second-largest segment will be the traditional, government-funded municipal wastewater treatment market, which should reach $300 million within two years. Build-operate-transfer (BOT) projects for municipal wastewater treatment comprise the third-largest segment, which is expected to reach $287 million by 1996.

The operation and maintenance of municipal wastewater plants and water distribution systems is the fastest growing component of the market (29%), and is expected to reach $85 million in 1996. In part because water distribution contractors are being required to install meters to enable municipalities to fully recover their costs for water services, the market for the associated instrumentation and metering equipment will expand at an average rate of 16% through 1996.

The market estimates in Exhibit 2-2 are based on the following assumptions:

- ***Economic growth.*** While the Mexican economy is expected to experience increased growth during 1995-1996, economic difficulties at the end of 1994 have dampened growth estimates. As government funding is often affected in a presidential election year, traditional government-funded projects declined in 1994, but may be authorized at a faster rate in 1995.

- ***Water market growth.*** Growth in water markets where financing is not tied to federal government institutions is likely to be the most stable. These include private sector wastewater treatment, instrumentation, and municipal BOT projects. The estimated sales in this market for 1993 were used as a baseline for determining the potential for future sales. It is estimated that approximately 100 treatment plants were installed in the private sector in 1993, averaging $2 million each; eight municipal wastewater BOT treatment plants averaging $20 million each were also installed.

  The PEMEX market experiences variable growth because PEMEX BOT projects are bid sporadically. Five projects, each worth approximately $50 million, were awarded in 1994, but it is not known if additional projects will be bid in the next few years. (It is conservatively assumed here that three such projects will come up for bid over the next two years, and that they will be let for bid simultaneously, as in the past.)

  The municipal instrumentation market was estimated to comprise 45 facilities in 1993 at an average cost of $350,000. The industrial instrumentation market is believed to have been 150 systems in 1993, at an average cost of approximately $200,000 each.

- ***Discharge tariff enforcement.*** The Comisión Nacional de Agua's (CNA) enforcement of water use and discharge tariffs will compel many of the larger companies, and eventually smaller dischargers, to invest in water pollution control and conservation.

- ***Financing availability.*** The availability of financing for large projects will improve as BOT-type arrangements are increasingly used in the municipal sector.

- ***Market drivers.*** In general, the industrial wastewater treatment market will remain more vulnerable to fluctuations in economic growth than the municipal market. The municipal market will be driven by national policy decisions to improve water quality in major cities throughout Mexico with third-party financing.

- ***Success of BOTs.*** The early success of several municipal BOT wastewater projects is likely to increase the number of future projects. The Mexican Government and multilateral banks are pushing for the wider adoption of this model in Mexico and for contracting out operations and maintenance (O&M).

- ***Municipal pressure on industrial dischargers.*** Pressure on industry to pretreat water to protect the operation of new municipal wastewater treatment plants will increase as new plants come on line in Monterrey in October 1994, and in other cities.

- ***Multilateral bank lending.*** Several new water sector loans will begin in 1995, which may lead to market growth (for example, the Inter-American Development Bank-funded wastewater treatment plants for the State of Jalisco are expected to be bid in early to mid-1995). The World Bank and the IDB are encouraging cost recovery, which cannot be accomplished without water metering.

- ***Bilateral bank guarantees.*** New guarantee programs for environmental projects with the Ex-Im Bank of the United States, and eventually the North American Development Bank (NADBank), will lower the risk to project sponsors and financial institutions for developing new municipal wastewater projects.

2.2 MARKET PERFORMANCE: 1992 TO 1994

Selected Firms Active in the Mexican Water Treatment Equipment Market	
Aqua-Aerobics Systems/Soliqtec	Illinois Water Treatment/ITENSA
Ashbrook Simon-Hartley/Servicios de Ingeniería del Medio Ambiente	Krofta/Krofta de México
BiWater/Agua de México	Lyonnaise des Eaux-Durnez de México/Degremont de México
Calgon Carbón/Calgon de México	Manning Environmental/Control Industrial
Cydsa/Atlatec	Microfiltration Systems/ARNI
Dicusa	North West Water
Dorr-Oliver/Dorr-Oliver de México	Sumitomo
Envirex/Belco Mexicana	Thames
Graver Water/Industrias Ecodyne	U.S. Filter/Continental
Hach Company/General de Laboratorios	Western Water Equipment/Soliqtec
	World Water Systems

Municipal BOT Projects

Mexican firms dominated this market during 1992-1994. Mexican construction firms, in particular, now qualify as the country's most important environmental companies. The dominant construction firms are FYPASA/Ecosys and Grupo Mexicano de Desarrollo. Although not a construction firm, Cydsa/Atlatec is another major competitor with roots in the petrochemical industry. Mexican firms have sometimes overcome as many as 30 competitors to win projects, earning up to a 35% return on their investment within five years.

Mexican firms carved out their dominant position by underbidding foreign competition. Price has been the overwhelming factor in awarding most municipal projects. Several Mexican firms that won bids have had limited experience in constructing wastewater treatment plants, and some U.S. companies question whether certain projects can be successfully completed and operated at the costs proposed. While low cost is part of many Mexican firms' strategy to gain a future competitive edge, some U.S. firms fear that these companies will negotiate adjustments to the inflation index in their contracts in order to compensate for low bids. However, there is some evidence that the bidding process is improving. For example, a recent award to Tribasa for a plant in Matamoros was formally disputed on the grounds that the company's proposed costs were too low and its per-liter charges too high.

U.S., British, and French firms each won only one municipal wastewater BOT award (which can include more than one plant) out of about twelve international solicitations between July 1992 and July 1994. Exhibit 2-3 shows the plants bid and the winners; note that many of these projects involve follow-on phases that are not shown in this exhibit.

Exhibit 2-3
Municipal BOT Wastewater Treatment Plants in Mexico (as of July 1994)

City	Unit	Volume (liters/second)	Awardee	Award Date
Chihuahua	Norte	1,200	Atlatec	Jul 1992
Puerto Vallarta	(One Unit)	750	BiWater	Jul 1992
Nuevo Laredo	(One Unit)	1,360	Atlatec	Oct 1992
Toluca	Oriente	1,000	Ecosys*	Dec 1992
	Norte	1,250	Ecosys	Dec 1992
Ciudad Juarez	Norte	2,500	Degremont	Jul 1993
	Sur	1,000	Degremont	Jul 1993
Ciudad Obregon	Norte	800	Tafer	Aug 1993
	Sur	700	Tafer	Aug 1993
Chihuahua	Norte	1,200	Atlatec	Jul 1992
	Sur	2,500	Atlatec	Oct 1993
Coatzacoalcos/	(One Unit)	500	Obras-	Nov 1993
Minantitlan		350	Portuarias	Nov 1993
Hermosillo	(One Unit)	2,500	NA	Jan 1994
Puebla	B. Conde	379	GMD**	Jan 1994
	San Francisco	1,257	GMD	Jan 1994
	Atoyac Sur	209	GMD	Jan 1994
	Parque Es.	467	GMD	Jan 1994
	Alseseca Sur	388	GMD	Jan 1994
Matamoros	Tlacaelel I	500	Tribasa ***	Mar 1994
	Tlacaelel II	350	Tribasa	Mar 1994
La Paz	(One Unit)	450	NA	In Progress

* Ecosys is a joint venture between FYPASA and VENTURA.
** GMD = Grupo Mexicano de Desarrollo.
*** Award disputed.
Source: Sierra International, Inc.

Although U.S. environmental firms have not succeeded in developing many of Mexico's municipal BOT projects, they have participated as equipment vendors or consulting engineers in winning consortia. According to Ecosys consortium members, for example, half of the $40 million in financing for the Ecosys I and II projects will be used to procure U.S.-manufactured equipment. The U.S. Filter project in Cuernavaca will rely on equipment imports from the company's California operations. U.S. consulting engineering firms participating in Mexican BOT consortia include Garcia and Associates from San Antonio. In contrast, several large Mexican companies like Grupo Mexicano de Desarrollo have not included any foreign design firms in their consortia.

With or without foreign participation, the municipal wastewater BOT market will grow steadily because the municipalities need the financing and have been willing to resolve some basic issues in order to obtain it. Municipalities have been given sole jurisdiction over tariff collection and payments to the treatment plant operator. Take-or-pay contracts are now well established in the potable water supply market segment.

Other issues have also been resolved. The issue of whether the plant developer must also provide associated infrastructure such as distribution systems or sewerage has often been decided in the private sector's favor. Additionally, reasonable precedents have usually been followed in establishing the duration of the BOT concession (12-15 years) and the amortization (20 years), thereby allowing the developer to offer a reasonable fee structure while earning an attractive rate of return. Finally, financial risks have been mitigated with state and federal guarantees in the event of municipal default.

Multilateral Bank-Financed Projects

BOT schemes have attracted great international interest, but have not yet displaced traditional public sector, donor-assisted wastewater treatment projects. Large loans from The World Bank[1] and Inter-American Development Bank have facilitated Mexican Government investment in water infrastructure projects. During 1992-1994, several major projects with multilateral bank financing were underway:

- ***Mexico Water Supply and Sanitation Sector Project (1991-1994).*** This CNA project was partially financed by a $300 million World Bank loan approved in January 1991; matching funds were provided by the Mexican Government. The loan supported CNA's Sector Reorganization Program, which was designed to improve water supply and sanitation services, promote sound pricing policies, and increase private sector participation. The project offered opportunities for the

[1] Since 1973, The World Bank has made six loans to Mexico in the water sector totalling $675 million.

private sector in construction and selected municipal services. It also helped lay the groundwork for future opportunities by building the capacity of local water authorities to conduct bids and engage private contractors. The loan also initiated a pilot pollution-control project launched in the Lerma-Chapala river basin, but because the subprojects financed under this loan were small in total dollar amounts, few foreign firms participated in the procurements.

- ***Support to the Water Supply and Sewerage Program (1992-present).*** This $200 million IDB loan to CNA supports the agency's sector reorganization program. The loan financed the expansion of systems and the streamlining of water supply and sewerage services. It was also used to rebuild the Guadalajara sewerage system following the 1993 sewer explosions. The project provided funding for the construction of 16 industrial wastewater treatment plants built by Mexican firms with foreign technology; these plants were built as part of the overall cleanup of the Lake Chapala-Río Lerma River Basin, one of Mexico's most important watersheds. This loan is not fully disbursed.

- ***Monterrey IV Potable Water and Sanitation Project (1990-1994).*** This project was approved in November 1990 and received $325 million of the total $750 million of IDB funding in water infrastructure investment for the city of Monterrey. With CNA and the Servicio de Agua y Drenaje de Monterrey as executing agencies, this project financed the El Cuchillo Dam, aqueducts, pumping stations, potable water plant expansion, distribution lines, sewers, and secondary wastewater treatment plants. It included an important Japanese financing component, and Sumitomo and Dicusa won the bids to build two of three wastewater plants. A U.S. firm provided the sluice gates for the spillways associated with the dam. In June 1994, this project was near completion.

In general, the experience of foreign companies with these multilateral projects has not been favorable. Opportunities have been limited because the technological requirements have not been particularly rigorous, the size of the subprojects has been small, and the construction requirements have been more easily met by local firms.

Industrial Wastewater Treatment

In general, Mexico's largest companies, both national and multinational, were the first to undertake wastewater treatment investments. During 1992-1994, industrial wastewater treatment projects in Mexico competed with higher-priority investments that increased productivity. Interest rates in the 25% to 30% range also slowed new investments, although new rules that allow the rapid depreciation of environmental investments are helping to offset this.

The institution of water use and discharge tariffs in Mexico has perhaps been the most important development in this market. The Mexican Congress sets these tariffs annually and CNA is charged with adjusting them quarterly and with collecting them. Water use tariffs cover usage from surface waters and wells, government-provided potable water systems, and discharges into receiving bodies. Discharge tariffs, on the other hand, are determined on the basis of volume, biological oxygen demand, and total suspended solids above the standard. Both use and discharge tariffs are further classified into four zones according to local water availability. Mexico's three major cities -- Mexico City, Guadalajara and Monterrey -- fall into Zone 1. Exhibit 2-4 presents the tariffs in effect in 1993. Note that they can be higher Zone 1 (up to 7 New Pesos per cubic meter of potable water used) where there are local tariffs.

Exhibit 2-4
Schedule of 1993 Industrial Water Use and Discharge Tariffs (NP/cubic meter)

	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec
		Use of Well Water		
Zone 1	1.3000	1.3458	1.3692	1.4137
Zone 2	0.9000	0.9317	0.9479	0.9788
Zone 3	0.3200	0.3312	0.3369	0.3480
Zone 4	0.2400	0.2484	0.2527	0.2609
		Use of Potable Water		
Zone 1	0.0600	0.0621	0.0632	0.0652
Zone 2	0.0280	0.0290	0.0295	0.0304
Zone 3	0.0140	0.0145	0.0147	0.0152
Zone 4	0.0070	0.0072	0.0074	0.0076
		Discharged of Industrial Wastewater into Water Body		
Zone 1	0.5083	0.5262	0.5353	0.5528
Zone 2	0.1270	0.1314	0.1336	0.1381
Zone 3	0.0508	0.0525	0.0534	0.0551
Zone 4	0.0253	0.0261	0.0265	0.0276
		Biological Oxygen Demand Discharge (per kilogram of BOD)		
Zone 1	0.3304	0.3420	0.3479	0.3593
Zone 2	0.0825	0.0854	0.0868	0.0896
Zone 3	0.0330	0.0341	0.0346	0.0358
Zone 4	0.0165	0.0170	0.0172	0.0178
		Total Suspended Solids Discharge (per kilogram of TSS)		
Zone 1	0.5846	0.6052	0.6157	0.6358
Zone 2	0.1461	0.1512	0.1538	0.1588
Zone 3	0.0584	0.0604	0.0614	0.0635
Zone 4	0.0292	0.0302	0.0307	0.0316

These tariffs, where collected, have encouraged private sector investments in water pollution control and conservation. Increased metering has occurred because federal legislation requires that industry meter its water consumption and because industry has an incentive to develop its own statistics on consumption. As a result, several U.S. firms like Krofta, World Water Systems, and Hach had large sales of either instrumentation or treatment equipment to private companies, even during the recession of 1993.

Another major development in the industrial market is the advent of BOT wastewater projects at state-owned industries. PEMEX pioneered this market in 1994 with the letting of five large petrochemical wastewater treatment/recycling projects at various refineries.

BOT Wastewater Treatment Projects at PEMEX

In 1994, PEMEX issued an international solicitation for the rehabilitation of wastewater treatment plants at five refineries. Its decision to invite the private sector to bid was driven by PEMEX's post-reorganization (1993) strategy to focus management attention on its main lines of business, which do not include wastewater treatment.

Each project cost between $40 and $50 million. The size and complexity of these projects stimulated the formation of bidding consortia that typically included a local construction firm, a foreign environmental engineering firm, and an investment house. The final awards, made in July 1994, went to the lowest bidders which passed the initial technical screening. All winners were Mexican-led consortia.

PEMEX BOT Awards, July 1994

Location	Refinery Capacity* (barrels/day)	Winner
Tula	315,000	Protexa
Cadereyta	235,000	GEMA**
Minatitlán	180,000	Agua Mejor
Salina Cruz	293,000	Bufete Industrial ***
Madero	195,000	GEMA**

* Actual capacity usually higher than rated.
** GEMA = Grupo Empresarial de Mejoramiento Ambiental
*** This award was cancelled in August; a new winner is to be determined.

Source: Sierra International, Inc.

2.3 BEST OPPORTUNITIES

With overall increases in economic growth, increased collection of water use and discharge tariffs, and the initiation of new multilateral-bank funded projects, opportunities for U.S. firms in the Mexican wastewater treatment market are expected to increase. Some of the best opportunities are described below.

Municipal Water Treatment Projects

The Mexican Government's goal is to provide sewerage to 15 million more people from 1992 to 2000 (Exhibit 2-5). This policy objective will open up additional opportunities for U.S. firms supplying wastewater treatment equipment, design services, and instrumentation. NAFTA should also help U.S. firms compete for sales in this market.

Exhibit 2-5
Water Supply and Sanitation Coverage in Mexico, 1970 - 2000
(population in millions)

Year	Total Population	Water Supply		Sanitation	
		Population Served	Percentage	Population Served	Percentage
1970	48.2	23.8	49.0	17.6	37.0
1980	67.4	46.9	70.0	32.9	49.0
1990	81.7	60.0	73.0	47.0	58.0
1990*	82.5	66.1	80.1	52.2	63.3
1991*	84.1	68.9	81.9	54.7	65.0
1992*	85.7	71.9	83.9	57.2	66.7
1995*	92.0	82.0	89.0	67.0	73.0
1996	92.2	81.9	88.7	69.2	75.0
1997	94.0	84.4	89.8	72.2	76.8
1998	95.7	86.9	90.7	75.2	78.5
1999	97.5	89.4	91.6	78.2	80.2
2000*	100.0	94.0	94.0	82.0	82.0

Note: 1990, 1991 and 1992 figures and projections for 1995 and 2000 are from CNA.
Source: World Bank/CNA.

Near-term (1994-1997) investments, totalling around $5.3 billion, will be financed by private sources and federal and state outlays supported by multilateral bank loans (Exhibit 2-6). Private capital is expected to become increasingly available; the Mexican Government estimates that the private sector will invest $700 million into this market between 1994-1997, and predicts a total of $1 billion by 1998. Because Mexican municipalities are not sufficiently secure financially to float bonds for financing infrastructure projects, these external sources of capital are essential for fueling growth in this market.

Exhibit 2-6
Mexico Water Supply and Sanitation Sector Projected Investment Plan 1994-1997 (millions of US$)

	1994	1995	1996	1997	Total
Water Supply	875	819	700	660	3,054
Sewerage	314	342	318	353	1,327
Wastewater Treatment	144	205	255	306	910
Total	1,333	1,366	1,273	1,319	5,291

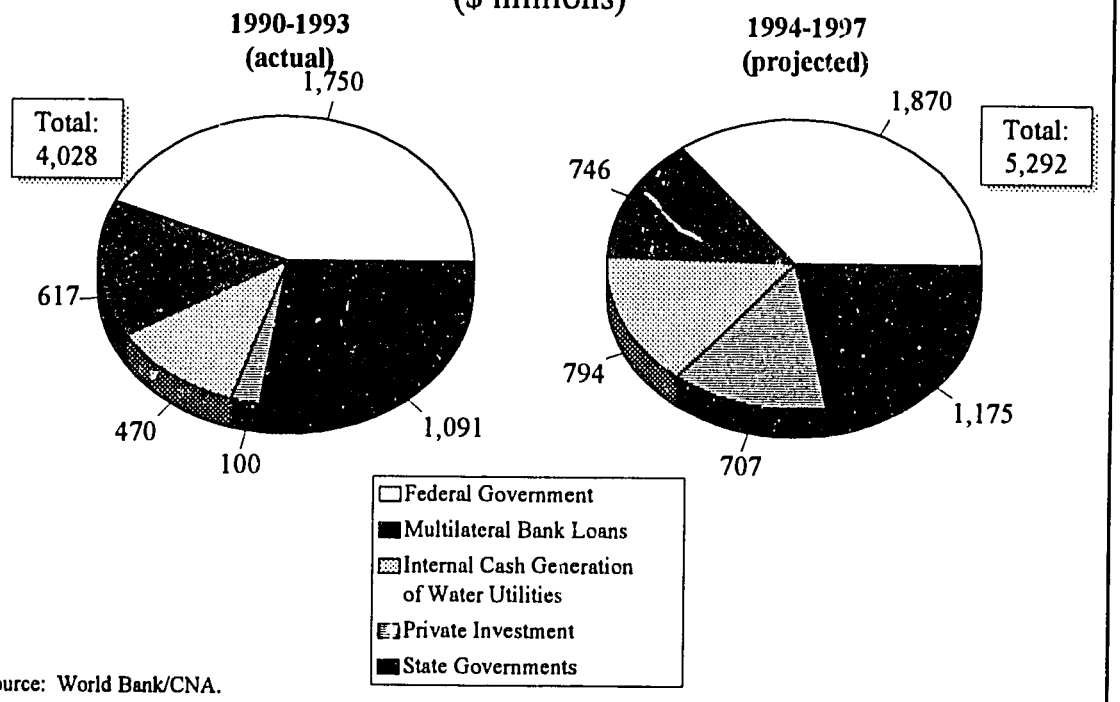
Source: World Bank/CNA.

The proposed $5.3 billion investment plan is an increase from the $4 billion that was invested in the sector during 1990-1993 (Exhibit 2-7). The percentage contributions from the Mexican Government (federal and state) and multilateral development banks would remain at 70% and 15%, respectively. Private investment, on the other hand, will increase from 2% to 13% of the total plan.

Multilateral bank-financed projects scheduled for 1994-1997 include the $350 million World Bank loan to CNA for the Second Water Supply and Sanitation Sector Project that was approved in June 1994. The project will be worth $770 million over four years; 85% of the funds will go for the procurement of water supply and sewerage works. Exhibit 2-8 shows the total cost estimate by project component. This project will also increase opportunities for U.S. firms by

supporting the development of the appropriate legal and technical frameworks to attract additional private investment.

Exhibit 2-7
Mexico Water Supply and Sanitation Sector Financing Plan
($ millions)



Source: World Bank/CNA.

In March 1994, the IDB approved a $169 million loan to support the $283 million Guadalajara Potable Water and Sewerage Project (Exhibit 2-9). This project is also partially funded ($60 million) by the European Investment Bank. Procurement is expected to begin in early 1995 and will include three water treatment plants of 1,000, 600 and 200 liters per second. Because of their large size, these plants will provide better opportunities for foreign participation than the projects funded under the 1992 IDB support to the Water Supply and Sewerage Project.

Future IDB loans will go towards the following projects, which are currently in the appraisal stage: the Mexico Irrigation and Drainage Program (a $300 million loan to be approved in 1995), the Basic Sanitation Program (a $600 million loan scheduled for 1995), and the National Potable Water and Sewerage Program (a $200 million loan scheduled for 1996). A project to support the construction of additional wastewater treatment plants in Mexico City is now in the project identification stage. The construction of these plants could be let as a BOT project with

minimal IDB participation. A loan designed to support water projects in Puebla has been postponed to 1995. Tijuana may also be a site for future IDB lending.

Exhibit 2-8
Mexico Second Water Supply and Sanitation Sector Project
Project Cost Estimate by Component (US$ millions)

Component	Local Funding	World Bank Funding	% of Total
I. Strengthening Sectoral Federal Institutions			
CNA	4.5	16.4	2.7
IMTA (Mexican Institute of Water Technology)	0.5	6.0	0.9
BANOBRAS	2.0	1.2	0.4
Subtotal	*7.0*	*23.6*	*4.0*
II. Investment Support to Local Water Utilities			
Water Supply and Sewerage Works	313.0	301.1	79.8
Studies and Design	21.9	21.1	5.6
Subtotal	*334.9*	*322.2*	*85.4*
III. Institutional Support for Water Utilities			
Preparation of MPs and EIAs	2.1	2.7	0.6
Support to the "Consolidacion" Program	6.0	1.5	1.0
Subtotal	*8.1*	*4.2*	*1.6*
Taxes	70.0		9.1
TOTAL PROJECT COST	**420.0**	**350.0**	**100.0**

MP = Master Plan, EIA = environmental impact assessment
Source: World Bank.

Another potential opportunity in this market has been identified by the U.S. Trade and Development Agency (TDA). In 1993, TDA funded a $589,000 feasibility study of a water treatment and supply project for Cuautitlan Izcalli County in the State of Mexico (referred to as the Lake Guadalupe Study). The study was conducted by a consortium led by Harza Engineering. The Lake Guadalupe project will involve a number of activities to clean up the environment around the lake including lake restoration, related wastewater collection and treatment, potable water supply, flood control and an irrigation system. The project will benefit 2.5 million people and cost nearly $1 billion. TDA estimates that projected U.S. exports for this project will amount to $250 million. The project envisions the construction and operation of three major systems: a wastewater treatment plant (40 million gallons/day; 1,752 l/s), a sewer collection system (for 150,000 people), and a potable water system (100 million gallons/day; 4,381 l/s).

Other opportunities may come out of the 100 Cities Program, which includes 45 priority water supply and wastewater treatment projects, requiring a total investment of $1.3 billion.

Exhibit 2-9
Guadalajara Potable Water and Sewerage Project
(US$ thousands)

Investment Category	Inter-American Development Bank	European Investment Bank	Local	Total	%
Engineering and Administration	4,880		3,800	8,680	3.1
Potable Water Treatment and Distribution	40,840		2,140	42,980	15.2
Municipal Wastewater Collection and Treatment	60,800	52,620	15,850	129,270	45.7
Training, Studies and Environmental Education	17,690		12,070	29,760	10.5
Other Costs (incl. interest, taxes, etc.)	44,790	8,880	18,640	72,310	25.6
Total	169,000	61,500	52,500	283,000	100.0
%	59.7	21.7	18.6	100	

Source: Inter-American Development Bank, 1994.

Additionally, a number of Mexican state and municipal government projects, without multilateral participation, are scheduled for 1995 and beyond:

- 48 wastewater treatment plants are planned throughout the Río Lerma/Lago Chapala watershed. Many of these projects could be performed as BOTs. Two state-sponsored projects in Jalisco are now on the drawing boards: Santa Cruz del Valle (projected to be 1,000 liters per second in 1995 and 2,500 liters per second in the future) and Santa María Troquepexpan (projected to be 300 liters per second in 1995 and 450 liters per second in the future).

- According to the DOC, the State of Chihuahua has also completed a water management master plan calling for an estimated 19 secondary treatment facilities and potentially $135 million in foreign procurements.

- Saltillo is considering the construction of a wastewater treatment plant at a total estimated cost of $100 million.

- Río Blanco is being restored in the State of Veracruz with associated opportunities.

- Enseñada is planning to expand two existing wastewater treatment facilities, install localized potable water plants, and modernize storm drainage infrastructure. The DOC estimates that this will include $25 million in U.S. equipment purchases.

Industrial Wastewater Treatment

Wastewater treatment and recycling technologies will be in demand for those industries that are short of water, that are facing stiff water bills and/or fines, or are exporting to the United States and, hence, potentially facing environment-related trade disputes under the NAFTA provisions. Industries that fall into at least one of these categories include automobiles, food processing, beverages and mining. The equipment and services in greatest demand will be:

- microprocessor-based control systems, using local components where possible, and offering product support
- systems that do not generate sludge, which is considered a hazardous material in Mexico
- instrumentation, particularly water use metering (Article 225 of the Federal Water Law requires that users install meters; European and Mexican companies winning water billing concessions are buying U.S. meters in many cases)
- projects with small consortia of Mexican manufacturers
- affordable consulting services to develop water demand management programs for industry
- design engineering services for treatment plants, particularly those tailored to the Mexican market.

Throughout the industrial wastewater treatment market, NAFTA will limit competition from companies from outside North America by providing specific tariff advantages to North American imports. Competition from within North America cannot be discounted, however, as Canadian firms are beginning to present more formidable competition. Also, some European firms with local licensing agreements should not be overlooked.

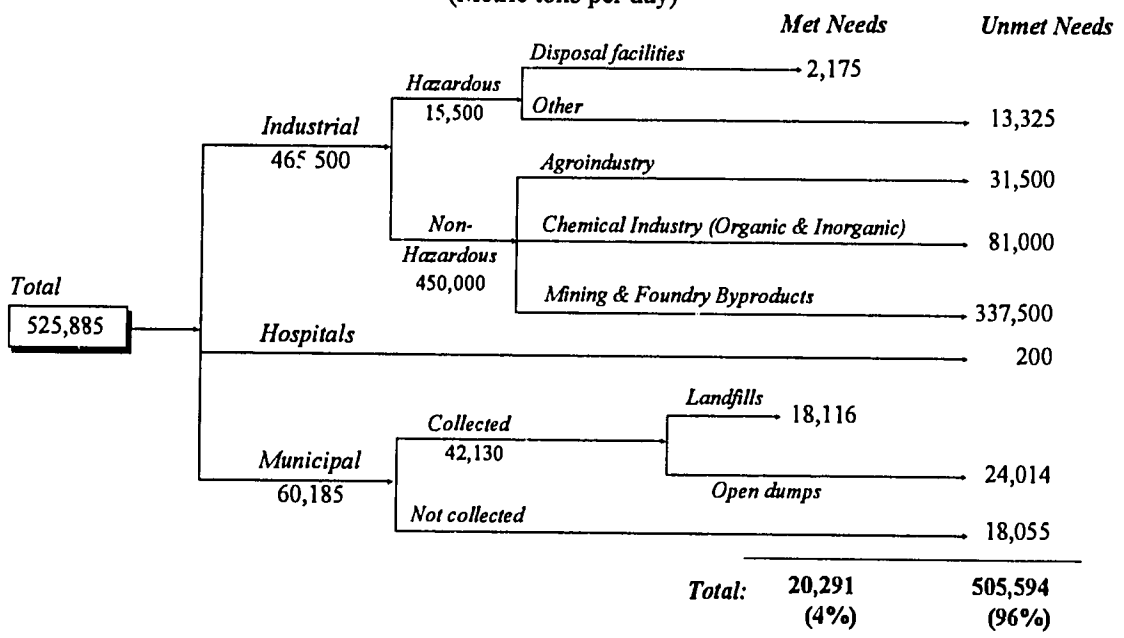
CHAPTER 3
SOLID AND HAZARDOUS WASTE

Key Market Segments

Municipal Solid Waste
Hospital Waste
Industrial Non-Hazardous Waste
Industrial Hazardous Waste

Mexico has a substantial need for solid waste infrastructure: only about 4% of the 525,900 metric tons of solid waste it generates each day is adequately managed. About 15,500 metric tons of Mexico's solid wastes are hazardous, with Mexico City producing 38% of these toxic substances. Exhibit 3-1 shows the daily solid and hazardous waste generation in Mexico.

Exhibit 3-1
Estimated Solid and Hazardous Waste Generation in Mexico, 1994
(Metric tons per day)



Source: Instituto Tecnológico y de Estudios Superiores de Monterrey/CNA.

Municipal Solid Waste. Exhibit 3-2 shows the generation of municipal solid waste in Mexico by region. Central Mexico generates nearly 44% of this waste, while Mexico City alone generates almost 14%. While the composition of municipal waste varies by region, food residues lead the list, followed by paper and garden residues.

Exhibit 3-2
Municipal Solid Waste Generated in Mexico by Region, 1992

Region	Population	Kg/capita/day	Metric tons per day	%
Border with USA	7,859,763	0.749	5,887	9.8
Northern	14,250,247	0.726	10,345	17.2
Central	40,886,107	0.642	26,249	43.6
Mexico City (D.F.)*	8,119,211	1.019	8,273	13.7
Southern	13,607,719	0.693	9,430	15.7
TOTAL	**84,723,047**	**(Average) 0.71**	**60,184**	**100.0**

* This figure includes the Federal District only.
Source: SEDESOL.

While there were 97 municipal landfills in Mexico in 1993, only 11 met regulatory standards (most of these were in the northern region). Municipal governments manage most of these sites. Typical landfills are open, unsecured dump sites that often accept hazardous waste in violation of federal regulations. Authorities have shut down at least 20 open dumps as health hazards in metropolitan Mexico City. As much as 74% of the population has no access to any landfill whatsoever. The only municipal incinerator is in Mexico City and it has been shut down for non-compliance with air emissions standards. Only two recycling-compost plants are operating (both below capacity).

Garbage collection is currently dominated by the municipalities and union interests. Disposal, on the other hand, is dominated by an important informal recycling segment controlled by *pepenadores* (scavengers). Household wastes are not separated in Mexico and the formal recycling segment is extremely limited.

Hospital Waste. Mexico does not yet effectively manage its infectious hospital waste. This waste is not, for the most part, properly separated at the source, an important step in identifying infectious material for proper disposal. Even when such separation occurs, incineration is often not an option because Mexican authorities have granted few permits for hospital incinerators. Consequently, the country disposes of much of its hazardous hospital waste in municipal landfills.

Industrial Non-Hazardous Solid Waste. The disposal of these wastes is also a problem in Mexico. By law, these wastes cannot be deposited in municipal landfills, although their disposal in hazardous landfills is unnecessary and expensive. As a result, some cities are building landfills especially designed for non-hazardous industrial wastes. Mining and foundry byproducts are the chief waste streams in this category, and the chemical and agro industries account for the other principal segments of this market.

Industrial Hazardous Waste. These wastes have the most rigorous technological requirements for processing and confinement. The market for their final disposal is divided between facilities serving paying customers and facilities built by and dedicated to private companies. Cement kiln incineration is also emerging as an alternative disposal option. Only one hazardous disposal facility with public access is operational in Mexico (at Mina, Nuevo Leon). However, that facility is allowed to use only 15% of the overall site. In the meantime, Mexican firms are expected to truck their wastes from across the country for disposal at this permitted facility. A second site in San Luis Potosí was approved in 1994.

The private sector lacks its own dedicated hazardous waste landfills. Only four are operational, owned by and dedicated to Ciba Geigy (Jalisco), Kimberly Clark (Mexico State), Procesadora Mexicali (Baja California), and Industrias Químicas (Jalisco). There is only one landfill authorized to receive non-hazardous industrial waste (in the border state of Tamaulipas) and there are very few incinerators anywhere in Mexico.

Because most industrial hazardous wastes in Mexico are either solvents (36%) or oils and fats (13%) (Exhibit 3-3), recycling is another important part of the hazardous waste market. Experts estimate that only 2% of potential recyclables are captured at Mexico's only operational hazardous waste dump.

Mexico City alone is responsible for generating 38% of the total volume of hazardous waste in Mexico; most of these wastes consist of spent solvents, oil and fats, and other wastes from manufacturing (Exhibit 3-4). Acid, alkaline and petroleum wastes are other toxic waste streams generated mostly in southern Mexico and the Gulf Coast (where PEMEX operations are located), central Mexico (where a rapidly growing mineral mining industry is located), and northern Mexico (where coal mining is concentrated).

Exhibit 3-3
Composition of Industrial Hazardous Wastes in Mexico, 1993
(shown as a %)

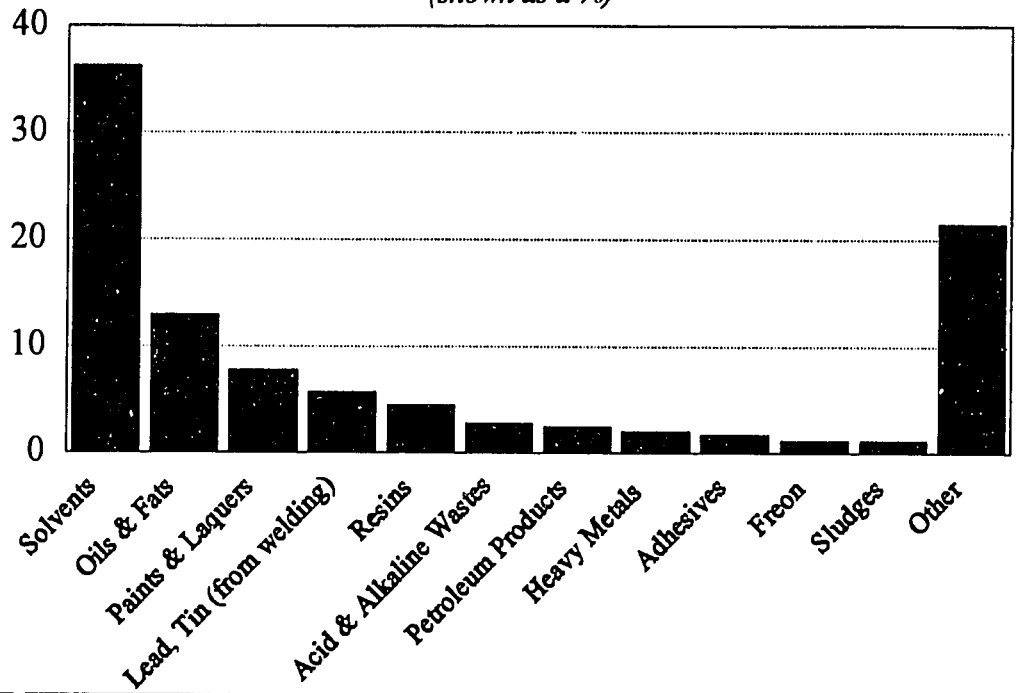


Exhibit 3-4
Hazardous Waste Generated in Mexico by Region, 1992

Region	Population	Grams/capita/ day	Metric tons per day	%
Border with USA	7,859,763	21	164	1.13
Northern	14,250,247	220	3,133	21.61
Central	40,886,107	51	2,100	14.48
Mexico City (D.F.)	8,119,211	298	5,515	38.04
Southern	13,607,719	264	3,588	24.74
TOTAL	**84,723,047**	**(Average) 171**	**14,500**	**100.00**

Source: SEDESOL.

The Instituto Tecnológico y de Estudios Superiores de Monterrey estimates that rectifying these infrastructure deficiencies would require an investment of $7.6 billion as of 1993 (Exhibit 3-5).

Exhibit 3-5
Investments Required for Unmet Solid and Hazardous Waste Needs in Mexico, 1993

	Unmet Needs (metric tons/day)	Treatment/Disposal Operations Required	Investment Requirement (billion $US)
Industrial			
Hazardous	13,325	Treatment and landfill	1.5
Non-hazardous	450,000	Landfill	2.6
Municipal			
Collected and disposed in open dumps	24,014	Classification, incineration, composting and landfill	2
Not collected	18,055	Collection classification, incineration, composting and landfill	1.5
Total	**505,394**		**7.6**

Source: Instituto Tecnológico de Estudios Superiores de Monterrey.

3.1 MARKET ESTIMATES

The market for solid and hazardous waste equipment and services in Mexico is estimated to reach $662 million in 1996. If new hazardous waste landfills are not included (their large sizes and sporadic implementation could mask trends in the rest of the market), this estimate represents an average annual growth of 29% per year between 1993 and 1996 (Exhibit 3-6).

The construction of sanitary landfills is expected to be the fastest growing segment of this market, growing at an average of 61% per year between 1993 and 1996. This figure, however, masks the low volume of activity predicted for this market. Only one sanitary landfill was known to be built in 1993 (in Cancún, at an estimated cost of $5 million). It appears that one or two such landfills will be built each year, reaching a modest total of $20 million in 1996.

The market for municipal collection services is also believed to be growing rapidly in Mexico: at an estimated average of 28% per year over the 1993-1996 period. This market segment's

expansion will be driven by municipalities' needs to recover the costs for their services, and will be facilitated by World Bank technical support to these services.

Exhibit 3-6
Solid/Hazardous Waste Market Estimates
(millions of US$)

Segment	1993	1994	1995	1996	Average Annual Growth 1993-1996
Municipal					
Recycling	7	7.5	8.5	10	13%
Collection Services	150	200	250	313	28%
Sanitary Landfills	5	10	15	20	61%
Hospital					
Incineration	5	5	7	9	23%
Industrial					
Recycling	20	18	20	23	5%
Incineration	0	20	23	77	N/A
Hazardous Waste Landfills	0	50	0	260	N/A
TOTAL	187	310.5	323.5	662	58%
Total – Hazardous Waste Landfill	187	260.5	323.5	402	29%

It is important to note that municipal collection projects sometimes include a landfill and even a recycling component, such as the project the Grupo Mexicano de Desarrollo won in November 1994 in the city of Puebla. These concessions could be worth an average of $30 million each (net present value); about five concessions have been awarded since 1993.

The construction of hazardous waste landfills will be an important market in terms of volume (an estimated $260 million in 1996), but may be small in terms of the number of projects. Only one project is under serious consideration over the next two years: the Mexico City facility, which is scheduled for bidding in 1995 but may be delayed until 1996.

Last, the incineration market is expected to grow quickly from its current small base ($5 million in 1993). Very few units may actually be installed in Mexico for reasons of siting and cost, although the number will increase in the coming years. Municipal and industrial recycling is also expected to grow significantly over the next two years. Municipal recycling may reach a 13% growth rate in 1994/1995 and 18% in 1995/1996.

These market estimates are based, in part, on an assessment of the following factors:

- ***Municipal recycling.*** The authors assume that President Zedillo will keep his campaign promise to promote recycling. He stated in his 10-Point Program for Mexico City that "it is necessary to utilize economic instruments to promote the use of recyclable materials in packaging and promote the practice of garbage separation in homes and businesses."

- ***Collection contracts.*** Despite a rough start, this market is expected to grow quickly. It is driven by:

  - the need to improve municipal collection services throughout the country
  - the need to implement financially self-sustainable municipal services
  - the application of this strategy in the 100 Cities Program
  - multilateral bank pressure and technical assistance to promote the use of outside contractors.

- ***Landfill construction.*** Although this market is constrained by the difficulty in obtaining site permits, Mexican cities will be pushed, both through the 100 Cities Program and by The World Bank, to sanitize open air landfills. President Zedillo has promised to close all open-air dumps in metropolitan Mexico City within three years. Also, Mexico has no choice but to establish non-hazardous industrial landfills to help manage this waste stream.

- ***Hospital incineration.*** Market growth will be constrained by permitting and financing issues.

- ***Industrial recycling.*** Increased solvent and oil recycling will, in part, drive the growth in this market. Industry will also be looking more closely at recycling as part of a waste minimization strategy.

- ***Industrial incineration.*** Cement kiln incineration is emerging as an alternative disposal option.

- ***Hazardous waste landfills.*** Public opposition will limit the number of hazardous waste landfills in Mexico. San Luis Potosí was authorized in 1994. Although no authorizations are expected in 1995, a large Mexico City project will likely be approved in 1996.

Most companies active in the market are either Mexican or U.S.-owned. Large international firms like WMX Technologies, Inc. have acquired smaller Mexican firms, particularly in municipal refuse collection. About 45 Mexican companies are authorized to provide environmental services in the identification, collection, transportation and disposition of solid and hazardous waste, according to the Department of Commerce. The capabilities and

competitiveness of these firms are strongest in solvents recycling and municipal solid waste services.

Selected U.S. Companies and Their Mexican Partners Active in the Mexican Solid and Hazardous Waste Market

U.S. Firm	*Mexican Partner*
WMX/Chemical Waste de México	ICA*; RIMSA**
BFI/BFI de México	Grupos Domos
Eco-MetalClad	Quimíca Omega
Morrison Knudson	n/a
Sanifill	Quinón (purchased)
SISSA	none
4M Environmental***	Eco-Administración
none	Bufete Industrial Ingeniería Ambiental
none	Promotora Ambiental/Gen Industrial

* WMX/ICA partnership formed Servicios Integrales de Protección Ambiental (SIPASA)
** strategic alliance with RIMSA; possible WMX future equity stake
*** joint venture between Martin Marietta and Molten Metal Technology

Several Mexican companies provide recycling equipment, including Bufete Industrial Ingeniería Ambiental (a subsidiary of the construction giant Bufete), Ingeniería y Saneamiento, and Constructora FCH. Química Omega and Texaco offer solvent and oil recycling services, respectively. Mexican companies offering incineration equipment include Bufete Industrial Ingeniería Ambiental, Incimex, Ingeniería y Saneamiento, Folamsa, Incineradores Villareal, Eco-Ingeniería, and Tecno-Adecuación Ambiental. European firms in the incineration market include Hoval and Ossler.

3.2 MARKET PERFORMANCE: 1992 TO 1994

Solid and hazardous waste markets have grown slowly over the last few years as Mexican municipalities have grappled with issues of siting, permitting, and contracting. By the end of 1994, it became evident that the market for municipal refuse management utilizing private contractors had clearly emerged as numerous municipalities succeeded in developing the appropriate contractual mechanisms and bidding procedures to allow private sector participation in this market.

Municipal Solid Waste

During 1992-1994, several projects for waste collection or the construction/operation of landfills were dropped, even after awards were made. A project in the City of Puerto Vallarta, for example, was put on hold after bids were submitted. In Catrel, another garbage collection project stalled when Simon Waste Management (U.S.) withdrew upon realizing that the market for compost in Mexico would not make the project viable. Bufete Industrial, one of Mexico's largest construction/engineering firms, has backed away from bidding on several projects because inadequate provisions were made to manage the issue of the *pepenadores*.

There were some successful developments. For example, WMX Technologies formed a joint venture with one of Mexico's largest construction and engineering conglomerates, ICA, which won several 15-year contracts beginning in 1993 to provide sanitation services in the states of Veracruz and Tamaulipas. In the summer of 1994, the city of Torreón, Coahuila awarded a contract for garbage collection in which some *pepenadores* were absorbed directly into the project. Another contract was awarded in Mérida, Yucatán, and there are several more underway. A favorable future trend thus appears to have begun in some states.

There are early signs that the municipal solid waste recycling market is also beginning to move. A good example is a project with financing from both the North American Environmental Fund and Grupo Cifra, a large food distribution company. This project calls for the installation of recycling centers in Superama supermarkets (the largest supermarket chain in Mexico). A small plastics plant formerly owned by Hoechst/Celanese is being refurbished as part of this project. Monterrey, which is further ahead in solid waste management than either Mexico City or Guadalajara, is just now beginning a program to separate household recyclables.

The landfill market was off to a somewhat slower start during 1992-1994 because of the difficulty in siting projects. Recent efforts to site facilities in southern Monterrey and Tlaenepantla have faced stiff media and community opposition. A notable exception is a project in Cancún, where Tribasa is installing a facility to capture 60 to 70% of the city's garbage. Tribasa has a 15-year, $7 million concession from the municipality to collect and process the waste.

Hospital Waste

This market began to emerge during 1992-1994. Because the Federal Health Law requires on-premise handling of toxic hospital wastes, the favored option is incineration, but permits have been difficult to secure. Only three hospitals have succeeded in obtaining permits and purchased European incinerators (Hoval and Ossler). The pent-up demand for incineration is so great that one hospital that obtained a permit now offers incineration services to third parties.

Industrial Non-Hazardous Waste

The non-hazardous industrial market grew during 1992-1994, at least in collection services. Companies like Promotora Ambiental (100% Mexican-owned) provide collection in Monterrey, for example, and take the waste to the municipal landfill. Quinón, now owned by Sanifill, is another Mexican company collecting in the border region. Monterrey is the farthest ahead in recycling, having established a clearinghouse for industrial recyclables in 1989-1990, the Bolsa de Residuos Industriales de Monterrey.

Industrial Hazardous Waste

In the hazardous recycling market, Texaco has been offering oil recycling services for a few years, but this business had mixed success in the 1992 to 1994 period according to some Mexican Government officials. Química Omega has begun a solvent recycling service in Jalisco, which appears to be enjoying success. While there is great interest in Mexico in Molten Metal's hazardous waste recycling technology, no deals have yet been struck.

Cement kiln incineration has emerged as a viable alternative to stand-alone incineration projects. The Mexican cement industry (one of the largest and most modern in the world) is estimated to have enough kiln capacity to burn up to 40% of the country's hazardous waste. Mexico's import/export bank, Banco de Comercio Exterior (BANCOMEXT), is now financing equipment for companies that collect these hazardous wastes (drums, paint cans, etc.) and the necessary air pollution control equipment for cement companies moving into this market. Chem Waste recently closed a deal with Apasco, Mexico's second-largest cement manufacturer, to burn hazardous and industrial waste at a cement plant in Coahuila. Química Omega/Metal Clad has been pursuing opportunities in this segment with Cemex, the country's leading cement producer.

Several waste-to-energy projects using tires as fuel were being developed in the states of Baja California and Hidalgo during 1992-1994; some of these projects have been blocked by community opposition. Venture capital firms interviewed for this study are looking at these projects, but claim that they are not in a position to move forward.

While little progress was made in 1992-1993 in permitting hazardous waste landfills, there was some movement in 1994. The Eco-MetalClad/Química Omega venture finally received authorization to open a secured facility in San Luis Potosí. RIMSA, which runs the only currently operational site in Mexico, is teamed up with Chem Waste to run the Mina, Nuevo Leon facility. That facility processed 180 metric tons/day in 1993, 92% of it from out-of-state. Some of Mexico's wastewater sludges, which are classified as hazardous, are disposed of in Mina. Chem Waste also operates a transfer station in Jalisco.

3.3 BEST OPPORTUNITIES

Although certain constraints persist in this market, some specific opportunities for U.S. companies are expected for 1995-1996:

- ***The World Bank Mexico Second Solid Waste Management Project***. This is a $415 million project with $200 million in World Bank funding to be disbursed over 1995-2000. The project is expected to improve solid waste services for an estimated 11 million people in 23 medium-sized cities (Exhibit 3-7). The project is also designed to help overcome municipalities' unfamiliarity with waste management contracting and related pricing, performance, and evaluation issues.

Exhibit 3-7
Mexico Second Solid Waste Management Project: Project Cost Estimate by Component
(US$ millions)

Component	Local Funding	World Bank Funding	% of Total
I. Institutional Strengthening			
SEDESOL	8.3	4.3	3.0
BANOBRAS	5.8	2.7	2.0
Subtotal	*14.1*	*7.0*	*5.1*
II. Investment Support for Implementation of Integrated Solid Waste Management Plan			
Civil Works	122.3	88.7	50.8
Equipment	41.0	47.4	21.3
Land	5.1	0.0	1.2
Subtotal	*168.4*	*136.1*	*73.3*
III. Social Component for Scavengers			
Infrastructure	2.3	0.0	0.6
Technical Assistance, Training and Studies	2.9	0.0	0.7
Subtotal	*5.2*	*0.0*	*1.3*
Contingencies and Taxes	**62.5**	**22.2**	**20.4**
TOTAL PROJECT COST	**250.2**	**$165.3**	**$100.0**

Source: The World Bank.

Investment support for the implementation of integrated solid waste management plans is the largest component (around 80%) of this project. This support involves a line of credit through BANOBRAS for onlending to municipalities or states for buying equipment and services. These plans will support full collection coverage in the municipality (including marginal areas); waste storage in high-density, polyethylene containers with lids; a modern collection fleet; least-cost final

disposal facilities including a minimum life span for sanitary landfills of ten years when that is the selected alternative; strict environmental pollution control measures, including clay or lining impermeabilization, leachate drainage and treatment of municipal hospital wastes; and closing of current inadequate dumpsites. Specific components to be financed include:

- civil works, such as transfer stations, landfills, incineration plants, containment cells for hospital wastes, recycling and composting plants, access roads and dumpsite closing

- purchase of equipment, vehicles, and spare parts for the collection, transport and final disposal of solid waste, including hospital waste handled by the municipality

- construction and equipping of recycling stations to provide a sanitary, safe and efficient environment for scavengers to continue their work near the sanitary landfills.

Additionally, $5.2 million will be allocated to helping the *pepenadores* make the transition to modern waste management, and $21.1 million will enhance the capacity of BANOBRAS and municipalities to enter into contracts with the private sector.

- ***IDB Sanitation Program for Mexico***. In addition to The World Bank loan discussed above, the IDB is planning to finance an even larger project-- a $600 million Sanitation Program for Mexico. The IDB loan component is expected to be approved in 1995. This project may focus on the country's largest cities.

- ***TDA-sponsored projects***. The U.S. Trade and Development Agency recently funded a feasibility study of a hazardous waste project serving Mexico City. The study examines a specific plan to construct a treatment, storage and disposal facility. It estimates a total project cost of $250 million, of which $50-100 million could be used to procure U.S. incinerators, drummed waste storage facilities, and analytical equipment. The Metropolitan Commission for Pollution Prevention and Control is the proposed implementing agency.

- ***Municipal services***. Municipalities that are well organized and willing to take on their local union leadership do not need to rely on multilateral funding in order to establish contracts with private firms. Around 114 cities are participating in the 100 Cities Program, and The World Bank project is funding only 23 of these. That leaves at least 91 additional medium-sized cities that will be modernizing

their sanitation over the next few years with purchases of trucks, liners, polyethylene waste storage containers, and testing equipment.

- ***Privatized landfills***. Monterrey's Sistema Metropolitano para el Procesamiento de Desechos Solidos (SIMEPRODE) is one of the few independent municipal waste disposal authorities in Mexico. The city plans to privatize the SIMEPRODE landfill (the only one in Monterrey) in 1995. Foreign consultants are developing the data and analyses that will be required to develop bid documents and to provide the municipal government in Monterrey with an estimate of the fair market value of SIMEPRODE.

- ***Industrial non-hazardous waste disposal***. Demand exists for appropriate disposal facilities for industrial non-hazardous waste that cannot legally be sent to municipal facilities (in addition, tipping fees at hazardous waste facilities are too high). It is likely that the Mexican Government will make the changes necessary to facilitate the permitting and construction of appropriate facilities over the next two years. One specific opportunity is in Monterrey, which plans to build such a facility in 1995.

CHAPTER 4
ENERGY EFFICIENCY

Key Market Segments

Cogeneration
End-Use Efficiency Technologies
Energy Services

Energy efficiency markets in Mexico comprise cogeneration; end-use energy efficiency technologies for industrial, commercial and residential applications; and energy services such as audits, engineering, implementation and shared energy savings contracts. Several assessments have been made to estimate the maximum potential for each of these market segments.

Cogeneration. Mexico's national energy conservation agency, the Comisión Nacional para el Ahorro de Energía (CONAE), calculates that Mexico has a maximum theoretical potential of about 20,500 MW of viable projects that could be developed among 2,500 Mexican companies. CONAE believes that large companies with projects greater than 50 MW represent 31.8% (6,500 MW) of this potential, and that PEMEX (the national oil company) could capture 20.5% (4,200 MW) of the total potential. However, there are only a few petrochemical companies in Mexico with a load over 100 MW and only about a dozen in the 50-100 MW range. In some cases, several medium-sized companies can be grouped together under one project, as has recently been done in Monterrey. Thus, the largest market segment by far is the under-50 MW size range. Exhibits 4-1 and 4-2 show the breakdown of CONAE's cogeneration estimates by sector and by region.

No one, including CONAE, believes that the maximum potential will be reached soon, partly because this potential represents about 70% of the Comisión Federal de Electricidad's (CFE, the state-owned electric utility, which owns and operates the national transmission and distribution system with the exception of Mexico City and its vicinity) total installed capacity. However, these figures do establish an upward limit.

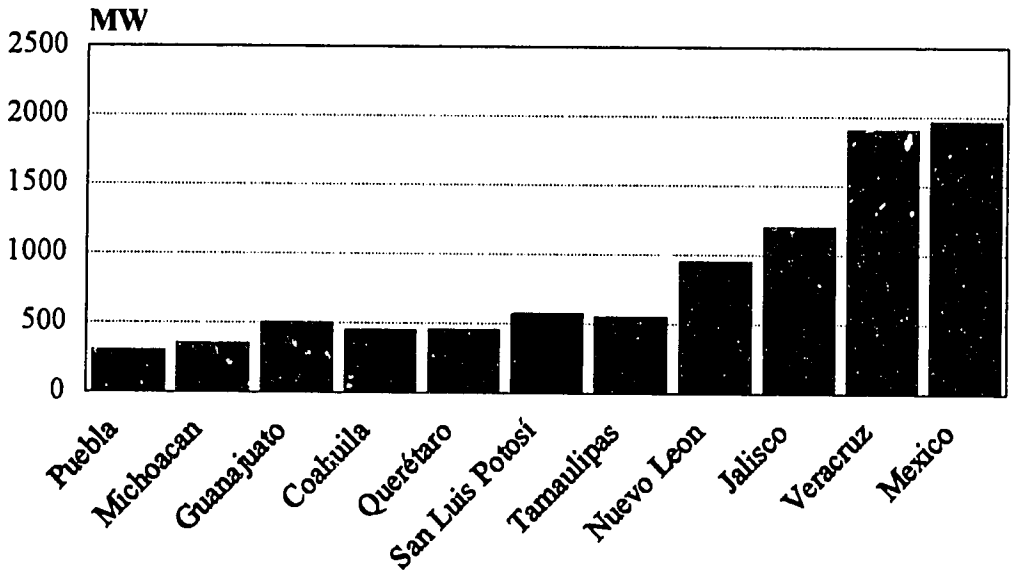
Mexico currently has about 2,000 MW of operational installed cogeneration capacity; this figure includes some captive generation at PEMEX. CONAE estimates that by 2003, Mexico could achieve between 4,200 and 11,000 MW of installed cogeneration capacity depending, in part, on rates of economic growth and sectoral performance (Exhibit 4-3). This would represent 9 to 23%

Exhibit 4-1
Maximum Cogeneration Potential in Mexico

Sector	Number of Facilities	Potential (MW)
Chemicals and Petrochemicals	348	2,400 - 6,061
Pulp and Paper	139	1,150 - 2,993
Food Processing	348	880 - 2,236
Metals	151	800 - 1,936
Sugar	34	800 - 2,112
Other	1,391	300 - 980
Subtotal	**2,411**	**6,330 - 16,318**
PEMEX	19	3,100 - 4,208
TOTAL	**2,430**	**9,430 - 20,526**

Source: CONAE, Coordinación de Cogeneración.

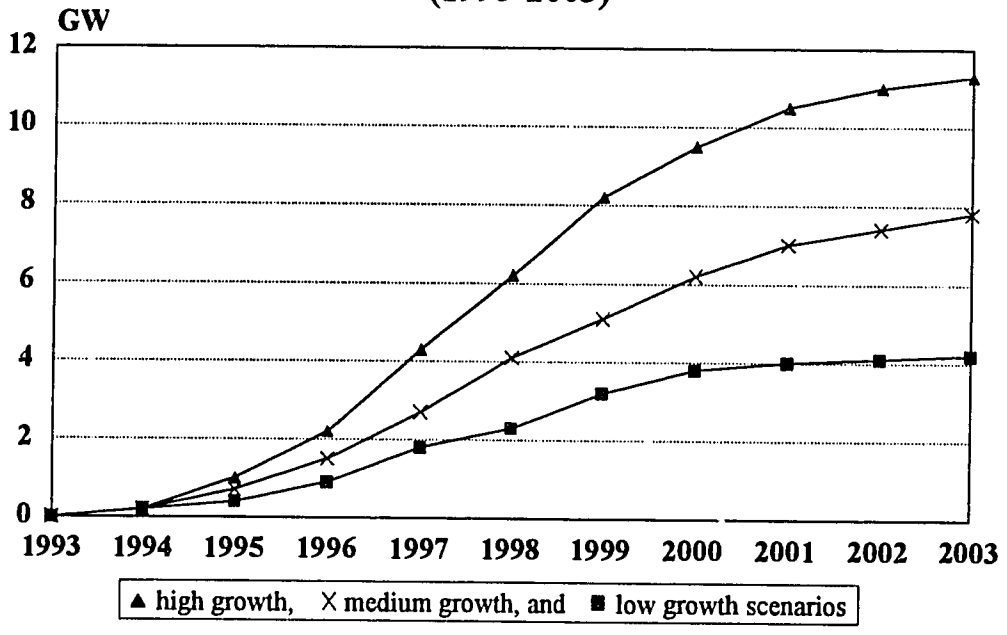
Exhibit 4-2
Mexican States with the Highest Industrial Cogeneration Potential



Source: CONAE, Coordinación de Cogeneración.

of CFE's projected capacity in the year 2003. CONAE concludes that a figure in the 4,200-6,750 MW range is a more realistic estimate over the 1993 to 2003 period.

Exhibit 4-3
Mexico Cogeneration Market Development Scenarios (1993-2003)



Source: CONAE, Coordinación de Cogeneración.

Electric end-use efficiency technologies. Based on a preliminary electric end-use efficiency study in the industrial sector (which accounts for over half the electricity used in Mexico), USAID's Office of Energy, Environment and Technology estimates that Mexico's industrial sector offers potential savings of 17,200 GWh in energy and 5,000 MW in demand in the year 2010 if major utility DSM programs were launched in 1994. These programs would target all industrial end uses including motors and drives, lighting, and industrial air conditioning, and result from penetration rates based on U.S. experience and benefit-cost ratios based on the total resource cost test (Exhibit 4-4). While innovative rates account for over 60% of demand savings, they contribute only about 10% to the energy savings; the remainder is due to new operational and technology improvements. CFE's own estimates for all sectors are included in Appendix A (Exhibit A-5).

Energy services. Energy services companies are beginning to perform projects in Mexico; most of these are Mexican firms leveraging in-house capabilities specific to certain industries. U.S. hardware for implementing energy services contracts has an excellent reputation, and NAFTA

Exhibit 4-4
Summary of Economic and Achievable Potentials for Mexico Industrial DSM Program

	Energy Use	Energy Savings			Demand	Demand Reduction		
	2010 MWh	2010 MWh	Percentage of Total Saving	Percentage of Total Energy Use	2010 MW	2010 MW	Percentage of Total Reduction	Percentage of Total Reduction
Industrial Sector:	159,445,348	(1)			28,015.77			
Motors & Drives	92,478,302				16,501.52			
Energy-Efficient Motors		2,337,435	13.61%	1.47%		313.41	6.26%	1.12%
Adjustable Speed Drives		2,689,266	15.66%	1.69%		214.56	4.29%	0.77%
Cogged V-Belts		63,081	0.37%	0.04%		8.46	0.17%	0.03%
Synchronous Belts		1,198.513	6.98%	0.75%		160.70	3.21%	0.57%
Motor Downsize Std 10 hp to hp		526,426	3.07%	0.33%		70.58	1.41%	0.25%
Motor Program Sub Total:		6,814,721	39.69%	4.27%		767.71	15.34%	2.74%
Lighting	9,327,553				1,665.94			
Interior Lighting		1,302,411	7.59%	0.82%		176.19	3.52%	0.63%
Exterior Lighting		120,571	0.70%	0.08%		15.73	0.31%	0.06%
Lighting Program Sub Total:		1,422,982	8.29%	0.89%		191.92	3.84%	0.69%
Industrial A/C:	1,036,394				185.88			
Energy-Efficient Air Con.		57,441	0.33%	0.04%		9.74	0.19%	0.03%
Low/No Cost Measures		6,896,816	40.17%	4.33%		924.70	18.48%	3.30%
Innovative Rates		1,977,076	11.52%	1.24%		3,109.00	62.14%	11.10%
Total Savings		**17,169,035**	**100.0%**	**10.77%**		**5,003.07**	**100.0%**	**17.86%**

Source: USAID Office of Energy, Environment and Technology.

now helps give hardware companies a slight but growing pricing advantage over other foreign equipment.

4.1 MARKET ESTIMATES

It is estimated that the Mexican market for energy efficiency projects, equipment, and services will reach $381 million in 1996 (Exhibit 4-5). This represents an average annual growth rate of 19% between 1994 and 1996. Cogeneration projects are believed to represent the single-largest share of the market: an estimated 94% in 1996. The cogeneration market is expected to grow around 20% per year through 1996; growth rates for energy-efficient technologies and services are expected to be in the range of 14% in the next two years.

These estimates are based on a number of factors that will drive growth in the coming years, including:

- ***Regulatory climate.*** A more favorable regulatory climate for developing private cogeneration projects is expected in 1995 and 1996, which should allow additional large cogeneration projects to go forward. This improved regulatory regime will also include increased buyback rates and new rates for wheeling.

- ***Technology advances.*** Advances in cogeneration technology such as packaged systems, integration with combined cycle technologies, and clean-burning gas turbines will help push this market forward.

- ***Higher tariffs.*** Increased tariff rates in Mexico will be a positive factor in promoting energy efficiency equipment sales. In recent years, CFE has raised tariff rates to between 147% and 183% of long-run marginal costs, except for residential rates, which lag at about 63% of the true cost of service. Continued cross-subsidies such as these are distorting end-use energy efficiency markets in Mexico.

- ***Political climate.*** Efficiency is a word commonly used by incoming staff of the new Zedillo Administration. The feeling is positive in the energy community in Mexico that energy efficiency will be more strongly supported.

Exhibit 4-5
Energy Efficiency Market Estimates
(millions of US$)

Segment	1993	1994	1995	1996	Average Annual Growth 1994-1996
Cogeneration	20.0	250.0	300.0	360.0	20%
High-Efficiency Technologies	12.0	13.5	15.4	17.5	14%
Energy Services	6.0	6.3	7.7	3.8	14%
TOTAL	38.0	269.8	323.1	381.3	19%

On the other hand, several factors may constrain growth in the energy efficiency market:

- ***Fuel supply.*** Fuel supply uncertainty will act as a constraint in the cogeneration market.

- ***Lack of information.*** Many medium-sized Mexican companies are unfamiliar with cogeneration and energy efficiency technologies in general.

- ***Lack of management commitment.*** Many Mexican companies are scrambling to restructure in order to compete under NAFTA and relatively few have the management resources or interest to undertake a cogeneration project, even if approached with an attractive turnkey plan. The exceptions are some of the large conglomerates like Vitro, Peñoles, Alfa and Cydsa, which have broader and more technical in-house capabilities.

- ***Constraints on DSM.*** Demand-side management programs, which can help expand the market for energy-efficiency technologies, face technical and institutional obstacles in Mexico, including poor metering, and a national electric utility which is only beginning to look seriously at such programs.

- ***Costs and financing.*** The high capital costs of energy-efficient technologies will also present a barrier. Furthermore, commercial interest rates remain high (in the 25-30% range), making even third-party financing extremely difficult.

Despite its enormous potential, Mexico's energy efficiency market performance was sluggish during 1992-1994. Surprisingly few cogeneration projects were built given the high level of expectation in 1992 and 1993. More recently, several important pilot projects, including a large World Bank Global Environment Facility (GEF) compact fluorescent residential lighting program, began to stimulate energy-efficiency technology sales, especially for compact fluorescent lamps.

4.2 MARKET PERFORMANCE: 1992 TO 1994

Selected Companies Active in Mexican Energy Efficiency Markets	
Cogeneration	***End-use efficiency technologies***
ABB	Bradley
Cogen Technologies	General Electric
Cogentrix	Honeywell
CSW	Johnson Controls
Electricite de France	Osram
European Gas Turbines	Philips
General Electric	
Grupo Alfa	***Energy services***
Mitsubishi	
Panda Energy	Altos Hornos de México
SEI	Energia Global
Siemens	Grupo Sidek
Stewart and Stevenson	Saincomex
Westinghouse	Peñoles
Zurn-Nepco	Vitro

Cogeneration

Despite important power sector reforms in December 1992 and the promulgation of associated regulations in 1993, virtually no major projects have been undertaken in the past few years. CFE has resisted the idea of cogeneration projects, offering to buy power at extremely low cost (in the 2-3 cent/kWh range). However, when developers have approached CFE with projects that are financially viable even at these low prices, CFE has been under no obligation to sign contracts to purchase cogenerated power; instead, it has handled all solicitations on a case-by-case basis. The lack of transparency in CFE's expansion plans has added more uncertainty to developers' efforts to plan cogeneration projects by making it difficult to determine where in the country CFE would most benefit from the energy that these projects could generate; however, this will ostensibly be solved by the annual publication of CFE's generation status and plans mandated by the new regulations.

In 1994, the market began to move again. On March 17, a consortium of developers received the first permission under the new private power law to build a 220 MW cogeneration facility in Monterrey with another 220 MW second phase (see box). This project, which represents an important milestone in the development of the market, aggregates several industrial customers to keep most sales inside the fence. This is the type of innovative scheme developers have had to devise to circumvent CFE's unwillingness to purchase excess power or to provide an attractive price for it. Appendix A (Exhibit A-6) lists the regulatory approvals that such a project requires in Mexico.

Energía de Nuevo Leon

Southern Electric International, Electricité de France, Industrias Monterrey (IMSA), and the State Government of Nuevo Leon recently formed a consortium, Energía de Nuevo Leon, to undertake an innovative, large-scale cogeneration project in Monterrey. The installation will be a 225 MW gas turbine combined-cycle plant.

IMSA could use up to 70% of the power for steel production; less than 20 MW will be sold to CFE (to avoid bidding requirements which are imposed on projects with more than 20 MW available to the grid), and the rest will go to other customers in the consortium. In this way, the 220 MW project will remain inside the fence, getting around restrictions on international private power projects in Mexico and on excess power sales to CFE. The project participants are close enough to each other (within 2 kilometers) to make the installation of private transmission lines economically viable. This is the first project of its kind to be approved in Mexico since the new Law of Electric Energy Public Service went into effect.

Project Participants

Fondo Financiero Nuevo León
Agua y Drenaje de Monterrey
Sistema Estatal de Agua Potable y Alcantarillado de Nuevo León
Sistema de Transporte Colectivo Metro
Fidecomiso Parque Fundidora
Industrias Monterrey
Acumuladores Mexicanos
Multipanel
Sthal
ESB de México
Aislantes León
Roberto Diener y Cia
Robertson Mexicana
Stabilit
Forjas Metalicas
IMSA Signode
Cuprum
Cogeneración de México

Source: SEMIP

At the end of November 1994, the official daily (*Diario Oficial*) published two long-awaited methodologies with respect to private power: 1) the pricing of power for less than 20 MW and 2) the calculation of transmission costs. The updated price formula is critical to understanding the power selling process. It should be used by private developers to sell power during the base, intermediate, and peak load periods at a maximum authorized tariff, including among other

factors, future changes in fuel prices and inflation.[1] The Methodology for Calculating Transmission Costs includes a procedure for calcuating transmission costs which includes four components: 1) fixed costs for using the grid, 2) variable costs for using the grid, 3) fixed costs for contract management, and 4) costs for connected services.[2]

End-Use Efficiency Technologies

Mexico has undertaken a number of energy efficiency projects over the last few years. Two major agencies are running these projects: CONAE, and FIDE (Fideicomiso de Apoyo al Programa de Ahorro de Energía del Sector Eléctrico, the private sector trust fund in support of the CFE program for electric sector energy savings). While CONAE has done numerous audits and boiler tune-ups, it has not been able to transcend the studies and achieve significant implementation. FIDE, on the other hand, is a dynamic, practical, implementation-oriented agency that has had significant successes in all energy-consuming sectors. While initially beginning with energy audits, the five-year old FIDE is now concentrating more on long-term development of energy efficiency markets, and working on trade ally relationships with various product manufacturers and vendors.

The biggest milestone in utility-scale DSM came with the initiation of the GEF/CFE/Norwegian-funded Ilumex project, which began in 1994. This project is designed to promote the high penetration of compact fluorescent lamps (CFLs) for residential applications in Monterrey and Guadalajara. Household lighting contributes substantially to Mexico's peak electricity demand, and the goal of this $23 million project is to disseminate 1.5-2 million CFLs in these two cities within a two-year period. This would eliminate emissions of 118,000 tons of carbon dioxide, 3,000 tons of sulfur dioxide, and 205 tons of nitrogen oxide annually. If 1.5 million CFLs are used four hours/day, the total peak capacity savings from the project could amount to a peak demand reduction of 78 MW and 135 GWh in avoided electricity generation per year.

Also in 1994, FIDE began an energy-efficient motor systems pilot project with collaboration from USAID's Energy Efficiency Project and various motor and drive manufacturers. FIDE has identified motors as an attractive target for energy conservation measures, particularly in the automobile assembly industry. Motors consume more energy than any other industrial end-use in Mexico (about 70%). The pilot will initially target 20 medium-sized industries in the central region of Mexico, and provide specifications, guarantees of energy efficiency performance, equipment monitoring, lower prices and participation in innovative financing schemes being

[1] The Methodology for Calculating Marginal Generation Costs and Benefits (Pricing Methodology for Excess Power of Less than 20 MW) is contained in the *Diario Oficial* of Thursday, November 24, 1994, 2nd section, pp. 1-4.

[2] The Methodology for Calculating Transmission Costs is contained in the *Diario Oficial* of Thursday, November 24, 1994, 1st section, pp. 2-9.

proposed for absorbing the incrementally higher costs of high-efficiency equipment. The objective is to be able to design a nationwide program with CFE support in 1996.

Energy Services

There are approximately 70 small Mexican consulting firms actively pursuing the energy audit and audit implementation markets. Their small size and the high cost of capital have severely limited their ability to finance such projects. Energy savings contracts began to emerge in Mexico in the last two years, especially in large corporations such as Grupo Sidek in the hotel industry, Peñoles in chemicals and mining, Vitro in glass manufacturing, and Altos Hornos in the steel industry. It is surprising that, given the energy saving potentials being identified in the audits, more U.S. firms have not become involved.

4.3 BEST OPPORTUNITIES

Despite the slow performance of the market during 1992-1994, significant opportunities will arise as developers find ways around regulatory constraints, as these constraints themselves diminish, and as technologies in some market segments capitalize on recent advances in cost reduction.

Cogeneration

The best opportunities will be with PEMEX, which now has some turnkey projects ready for international bidding (the Antonio Dovali Jaime Refinery in Salina Cruz and the Miguel Hidalgo Refinery in Tula are probably included in this group). PEMEX's recent letting of build-operate-transfer (BOT) wastewater treatment plants at refineries may set a precedent for BOT cogeneration projects, particularly in PEMEX's refining subsidiary. In December, SEMIP announced that it had authorized the construction of ten cogeneration plants which would produce approximately 400 MW altogether.

The private sector also has several projects ready to go as soon as CFE's buyback rates increase (anticipated for the fall of 1994). Other opportunities will lie with users and hosts teaming up and using Energía Nuevo Leon as a model. Hundreds of opportunities in the under-50 MW range exist in Mexico, but these manufacturers will be more difficult to work with and less interested in undertaking a project at a time of corporate restructuring. Nevertheless, some small-scale developers with the interest and persistence could walk away with some good projects that do not capture the attention of the larger players. According to CONAE, the best opportunities, in order of priority, will lie in:

- Petrochemicals
- Foods and Beverages
- Paper, Pulp and Textile
- Glass and Ceramics
- Steel
- Automotive and Metal Parts.

In July 1993, CONAE concluded a study of various potential cogeneration projects that could be developed. Appendix A (Exhibit A-7) summarizes the results of this study.

End-Use Efficiency Technologies

Significant opportunities are expected to arise for the sale of CFLs for the Ilumex Project and follow-on residential lighting programs. Project sales goals are shown in the box on the following page. Both short- and long-term opportunities for sales of energy-efficient motors and drives are expected to arise directly from the Motor Systems Pilot Project of FIDE. As Exhibit 4-6 shows, in addition to motors and drives, lighting and air conditioning measures are economically attractive and will eventually be promoted.

Future plans for CONAE call for increased attention to combustion efficiency. Programs aimed at this area will foster the growth in fuel, gas and steam metering systems, exhaust gas analyzers, fixed combustion analyzers and controls, high-efficiency burners, heat recovery systems and new boilers.

Ilumex Project Sales Goals, by Semester

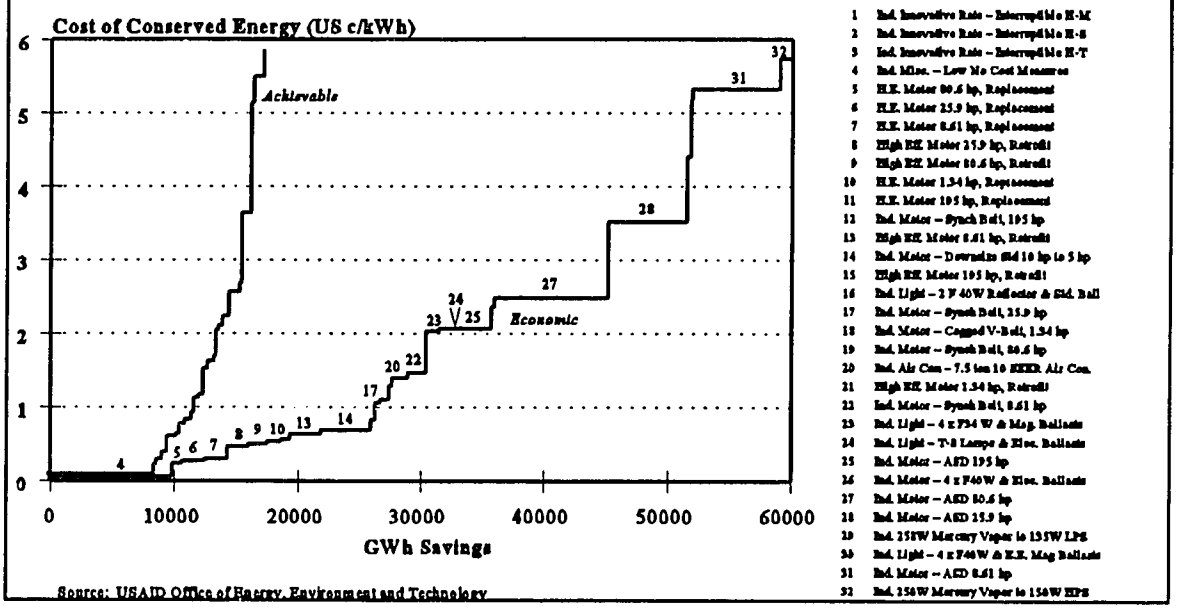
Semester Ending	*Monthly Sales*	*Accumulated Sales*
Dec 1994	29,500	177,000
June 1995	73,500	618,000
Dec 1995	73,700	1,060,000
June 1996	73,500	1,501,000
Dec 1996	33,000	1,700,000

Source: GEF

The equipment market will also receive a boost when Mexico's Credit Union for Energy Efficiency (UCEE) begins operation in late 1994. UCEE will be a nation-wide credit union to fund energy efficiency projects. The size of the fund is around $1 million and the first projects are being initiated this year. The credit union will lend at around 19%. This credit union has

already received preliminary requests from chemical, steel, glass, ceramics and agro-industries to fund 360 projects in 1994, each with a loan averaging $50,000. Because of delays in getting the credit union started, many of these loans will be made in 1995.

Exhibit 4-6
Cost of Conserved Energy vs. GWh Savings in 2010
(Mexico Industrial Sector)



Source: USAID Office of Energy, Environment and Technology

Energy Services

FIDE and CONAE will continue to be the primary catalysts for the energy audit market. As part of the next World Bank power sector loan, CONAE expects several million dollars for efficiency programs. The real growth in energy services, however, will come from the private sector market. The large tourist hotel sector in Mexico is ripe for U.S.-type energy service companies (ESCOs) to provide third-party financing and performance contracts for energy savings. Industries and the rest of the commercial sector will also offer opportunities, especially as the economy begins to grow again. The use of U.S.-based financing for energy efficiency, at significantly lower interest rates than available commercially in Mexico, should prove attractive, even accounting for transaction costs and exchange rate risks.

CHAPTER 5
RENEWABLE ENERGY

Key Market Segments
Utility-Scale Renewables
Intermediate/Small-Scale Renewables

Because environmental performance in the energy sector has become a global issue, Mexico is receiving bilateral and multilateral funding for alternative energy projects.

Utility-scale renewables. With intense sunlight in the north, vast biomass resources in the south, rapid winds over the Isthmus de Tehuantepec, Quintana Roo, Oaxaca, Guerrero, Hidalgo, Michoacán, Baja California, Zacatecas, and Coahuila, and chains of ancient volcanoes that house vast geothermal resources, Mexico has great potential for utility-scale renewable energy development. Like other North American countries, Mexico has largely exploited its hydropower resources, although its water resources are limited. Besides hydro, geothermal is the only other large-scale renewable energy resource that is considered conventional in Mexico. Mexico ranks third in the world in geothermal capacity with 753 MWe of installed capacity, over 80% of which is found in the Cerro Prieto field in Baja California.

Intermediate/small-scale renewables. The potential in this market segment is also large. Renewables could provide power to the 85,000 communities that have yet to be connected to the electricity grid (these communities, each with less than 500 people, hold about 10% of Mexico's population). Other important applications include powering remote telecommunications relays and oil rig lighting or communications. The government-subsidized photovoltaic market is expected to reach nearly 10,000 homes in 1994 and over 30 community centers. Three micro-hydro units are also planned. All this represents government financing of nearly $12 million in 1994. The private sector market will hit 15,000 installed intermediate/small-scale renewable systems in Mexico at the end of 1994 and 8,000 telephone relays. There are relatively few hybrid systems in Mexico at present.

5.1 MARKET ESTIMATES

The market for renewable energy in Mexico may reach an estimated $699 million by the close of 1996 and is expected to grow 6.4% between 1995 and 1996 (Exhibit 5-1). The largest markets will be for large-scale hydroelectric power plants and for large captive power systems using windfarms. The hydropower market is expected to recover in 1995 after the 1994 presidential election year, in which large-scale projects were not readily approved by CFE (the national electric utility). Over the next two years, it appears that CFE will be bidding at least one large hydropower plant each year.

Exhibit 5-1
Renewable Energy Market Estimates
(millions of US$)

Segment	1993	1994	1995	1996	Average Annual Growth 1995-1996
Conventional Utility Scale					
Lg Hydro	375.0	125.0	375.0	375.0	0.0%
Geothermal	112.8	0.0	112.8	112.8	0.0%
Large Captive Power					
Wind	0.0	0.0	135.0	160.0	18.5%
Biomass	0.0	5.4	13.5	27.0	100.0%
Intermediate Scale	**11.2**	**12.5**	**13.7**	**15.4**	**12.1%**
Small Scale*	**4.6**	**5.8**	**7.3**	**9.2**	**25.0%**
TOTAL	**503.6**	**148.7**	**657.3**	**699.4**	**6.4%**

* Includes photovoltaic modules only.

Windfarm developers should begin to receive authorizations for projects in 1995, when 100 MW could be approved by local municipalities, CFE and SEMIP. Also, several large captive power projects under development in 1993 and 1994 are expected to move forward beginning in 1995. The market is expected to reach 60 MW in 1996, for a total volume of $160 million.

Geothermal market development is expected to closely follow CFE's expansion plans, which call for about 70 MW of geothermal capacity in 1995 and again in 1996. Large-scale biomass and intermediate-scale systems (including mini-hydro, intermediate wind, and various hybrid

projects) for productive uses should begin to see significant growth in Mexico over the next two years, together with sales of photovoltaic modules, which are expected to reach 1 MW in sales in 1996 at a value of $9.2 million.

These market improvements will depend on whether the Zedillo Administration begins authorizing large hydro and geothermal projects, regulatory restrictions ease, buyback rates improve, wheeling rates become more transparent, and CFE begins to formally solicit private power projects to incorporate into its 1995 expansion plan.

Several factors will affect growth in the utility-scale renewables market as well as the U.S. share in this market:

- ***Geothermal expansion***. Geothermal is considered a conventional resource in Mexico. CFE's latest expansion plan calls for installing an additional 213 MWe of geothermal power between 1994 and 2003.

- ***Wind***. Wind power is too new to Mexico to capture much of the utility market in 1995 or 1996, despite its very good long-term potential. Several developers are nevertheless working on large captive power projects designed to sell excess electricity to the grid. Some of these projects are expected to come to fruition over the next two years.

  U.S. wind manufacturers will face strong foreign competition in Mexico from the Danes, Germans, and Japanese despite the benefits of NAFTA.

- ***Solar***. Mexicans still view solar parabolic technology as too expensive. A Luz-type system will be contingent on World Bank Global Environment Facility (GEF) funds buying down the cost of such a project. While this is certainly a possibility, it may not result in a completed deal during 1995-1996.

The factors that will affect growth in intermediate/small-scale renewables include:

- ***Social programs***. The PRONASOL Program (see Section 5.2 for details) is likely to continue promoting photovoltaic rural lighting applications in 1995 and 1996.

- ***Rural programs***. Growth in micro-hydro, small biomass and stand-alone wind systems will be driven by programs designed to promote productive uses of renewable energy in the countryside.

- ***New construction***. The continued aggressive penetration of telecommunications into remote areas, and the construction of PEMEX oil platforms and hotels in resort areas will help drive the small-scale market.

With the advent of NAFTA and Mexico's OECD membership, the playing field is becoming more level. In the past, European and Japanese competitors had better access to soft loan financing from their governments. Since Mexico joined the OECD in 1993, European (Italian) competitors will have difficulty in providing soft-loan financing for projects in Mexico. European Community guidelines restrict the provision of subsidized credit to OECD members; hence, Spain's Linea del Rey, one of Europe's softest credit lines ever to Mexico, is now terminated.

Many of the intermediate/small renewable systems, on the other hand, particularly photovoltaic auxiliary components, are not an import market in Mexico. Formidable local competitors like Condumex will strictly limit growth for imported balance-of-system components, even under NAFTA.

Overall, the most immediate benefit of NAFTA for U.S. manufacturers of renewable energy technology is the progressive elimination of almost all import duties on trade between the U.S., Canada and Mexico for goods qualifying as North American under NAFTA's rules of origin clause. For most of the following goods, the existing tariffs will be either elimminated immediately or phased out within five of ten years:

- U.S. exports of wind turbines to Mexico currently face a 20% tariff; this will be phased out in ten equal stages over ten years.
- U.S. exports of solar photovoltaic equipment to Mexico faced a 10% tariff; this was phased out with the implementation of NAFTA.
- Most other renewable energy and energy efficiency technology exports to Mexico face tariffs of 10% to 20%; these will be phased out within ten years.
- Competitors for renewable energy and energy efficiency technology exports to Mexico, namely Europe and Japan, continue to face duties of 10% to 20%.

5.2 MARKET PERFORMANCE: 1992 TO 1994

Despite the positive outlook for 1994 and beyond, Mexico's renewable energy market performance was sluggish during 1992-1994, with the exception of large hydropower projects and photovoltaic modules imported from the United States. A few intermediate-scale wind, solar or wind/solar hybrid projects have been developed, but no large-scale projects have yet gone forward using these resources. The principal reasons continue to be regulatory restrictions on development and lengthy negotiations with CFE regarding power sales to the utility.

Utility-Scale/Large Captive Power Renewables

In the utility-scale market, no alternative renewable energy projects (wind, solar) have yet been built in Mexico. This is not true for conventional (hydro and geothermal) renewable energy. Over the years, Mexico has installed 8,171 MW of hydroelectric and 740 MW of geothermal capacity, representing 28% and 2.6%, respectively, of the country's total installed capacity. CFE recently developed a 50 MW geothermal power plant using U.S. technology. Additionally, several large hydro projects have been built or started, including a 960 MW facility in Aguamilpa, Nayarit. This project will cost over $1 billion and is one of Mexico's largest hydropower projects ever. Large hydro projects under construction or awarded are shown in Exhibit 5-2.

Geothermal plants in Mexico operate at an average 90.5% plant factor, among the highest in the world. This helps in part to explain why, even though these plants represent only 2.6% of capacity, they account for 4.7% of total electricity generation in Mexico. Perhaps the reason CFE has not favored geothermal plants is that, in developing its resource plan, the utility used the assumption that a geothermal facility will have a life of 20 years, which is shorter than any other resource option considered except diesel.

Exhibit 5-2
Recent CFE Hydroelectric Projects

Name	Unit	Capacity (MW)	Operation Month/Year
Aguamilpa	U-1	320	Feb 1994
Aguamilpa	U-2	320	Apr 1994
Aguamilpa	U-3	320	Jun 1994
Chilatan	U-1	14	Mar 1997
Huites	U-1	200	Apr 1995
Huites	U-2	200	Jun 1995
Zimapan	U-1	140	Jun 1995
Zimapan	U-2	140	Sep 1995
Temascal II	U-2	140	Sep 1995
Temascal II	U-1	100	Jun 1996
San Rafael	U-1 thru U-8	24	Nov 1996
Tecate	U-1	30	Mar 1997
Chilatan	U-2	14	May 1997
Tecate	U-2	30	Jun 1997

Note: Aguamilpa began operation in July 1994.
Source: CFE.

Selected Companies Active in the Mexican Renewable Energy Market

Utility-Scale Renewables

American Windpower	Enron	Packe
Barber Nichols	Ensaldo	Sea West
Benholt	Kenetech Windpower	Sterling Toshiba
Canon	Micon	U.S. Generating Company
Condumex	Mitsubishi	Vestas
Cummins	New World Power	Zond
Energy Performance Systems	Ormat	

Small/Intermediate-Scale Renewables

Acumex	Johnson Controls	Solartronic
Bergey Windpower	Kyocera	Spencer Management Associates
Condumex	R. Lynette & Associates	SunPower
Domestic Technology International	New World Entec	Sun West Energy Systems
Eco Systems	New World Village Power	Tacumex
Enersol Associates	Photocomm	U.S. Generating Company
FloWind Corporation	Pycorsa Stanley	United Solar Systems Corporation
Geo Solar Energy Systems	Radco	Westinghouse Advanced Energy Systems
Heliodyne	Siemens Solar	Zomeworks/Solo Power
Integrated Power Corporation	Solar Outdoor Lighting	
Israsol	Solarex	

An important development is the application of the build-lease-transfer mechanism for financing projects in this segment of the power sector. This model has been used for all recent geothermal projects in Mexico. Another innovative development in this market is the contracting out of well drilling and operation. For example, CFE buys 15% of the steam in the Cerro Prieto field, Mexico's largest, from a private contractor. Recent geothermal projects begun or awarded are shown in Exhibit 5-3.

Exhibit 5-3
Recent CFE Geothermal Projects

Name	Unit	Capacity (MW)	Operation Month/Year
Azufres	U-10	5	Feb 1994
Azufres	U-11	2	Feb 1994
Azufres	U-12	2	Feb 1994
Humeros	U-6	5	Mar 1994
Cerro Prieto	U-3	20	Dec 1996
Maritaro	U-1	20	Mar 1997
Cerro Prieto	U-4	20	Mar 1997
Maritaro	U-2	20	Jun 1997
Cerro Prieto	U-5	20	Jun 1997
Cerro Prieto	U-6	20	Sep 1997

Source: CFE.

To date, the United States has not been very competitive in the Mexican geothermal market for prime movers, which has been dominated by Mitsubishi (Japan), Toshiba (Japan) and Ansaldo (Italy). The Ormat binary geothermal plants on the Los Azufres field are notable exceptions. U.S. firms in the drilling and well maintenance segment have fared much better. Of the total installed geothermal capacity in Mexico, U.S.-led projects account for only 7.8%, and most of that is the result of a major recent 50 MW project. This project was the direct result of the sale of a once-experimental General Electric turbine designed and manufactured with funding from the U.S. Department of Energy. This sale occurred in early 1994.

U.S. Binary Geothermal Power Plants in Mexico

CFE commissioned two 1.5 MW binary geothermal power plants using technology provided by Ormat, a leading U.S. binary geothermal technology company based in Nevada. The two plants are located in the Los Azufres geothermal field in Central Mexico and use separated geothermal brine. All engineering and construction, including installation, well pumping and electrical connections, were locally designed and executed by CFE and other Mexican companies. The plants were commissioned in November 1993.

Source: Ormat.

The 1992-1994 period saw some gradual changes in power sector regulations that have provided an opening for large-scale, captive wind projects. In September 1993, New World Power signed agreements with land owners in the La Ventosa region covering 37,500 acres. New World plans to develop the region over the next 10 to 15 years and is negotiating to sell the first 60 MW, with half going to municipalities/direct retail and half to the national utility. For example, with sales to the local government to power municipal lighting, this initial project -- and others like it -- could technically remain "inside-the-fence" and hence cross no regulatory barriers. But excess power would have to be sold to CFE during the day, and CFE will decide if it is predisposed to buy this power and at what price. In any event, wind is not likely to be receiving any capacity credits in Mexico in the near future.

One group of developers is attempting to attract interest for the construction of a solar parabolic trough system similar to the Luz systems in southern California. Spencer Management Associates is heading up this effort to deploy an integrated-solar, combined-cycle system (ISCCS) in northern Mexico where the climate and solar conditions are the same as those in southern California (364 MW of installed solar trough systems are currently in operation in California). The viability of this project in Mexico will depend in part on grants from the GEF to buy down the initial fixed costs, given that the benefits from economies of scale would take time to materialize.

Few, if any, large-scale biomass projects were implemented during 1992-1994 and only one captive private hydro project may have been initiated during the same time period. Hydro projects have been constrained by intense regulatory oversight in Mexico, where water resources are scarce. In December 1994, it was announced that three hydroplants were authorized by SEMIP to be built in the Federal District: Los Palmas, San Bartolito, and El Borracho. These projects tap into city water and do not tap natural waterbodies.

Intermediate/Small-Scale Renewables

In 1989, the Mexican Government established a far reaching social program called Programa Nacional de Solidaridad (PRONASOL). This program has become the driving force in the rapidly-growing photovoltaic market. Based out of SEDESOL, PRONASOL will have spent nearly $35 million between 1989 and 1994 on renewable energy systems for rural village applications. The majority of these are small, household photovoltaic systems to power lights. The U.S. Department of Energy and USAID are supporting PRONASOL through an informal cooperation program known as the *Programa de Cooperación en Energía Renovable* (PROCER).

In 1992, PRONASOL roughly doubled the number of systems installed in Mexico over the previous three years. Community systems grew 26% in 1992 over the existing base, and the number of units installed in 1993 continued to grow quickly. A few microhydro and hybrid

systems were also installed under this program during 1989-1994. Exhibit 5-4 shows the PRONASOL-funded renewables projects during 1991-1994.

Exhibit 5-4
PRONASOL-Sponsored Small-Scale Renewable Energy Projects
(1989 - 1994)

Year	Population Served (persons)	Houses with Individual Systems	Community Systems		Hybrid Systems	Approximate Investment ($ millions)		
			Public Services	Microhydro		Individual Systems	Community Systems	TOTAL
1989-91 (cumulative)	33,865	5,965	67.0	1.0	6.0	6.0	1.3	7.3
1992	28,875	4,765	13.0	5.0	1.0	4.0	2.0	6.0
1993	37,204	7,321	15.0	0.0	1.0	8.0	0.4	8.4
1994 (projected)	50,046	9,806	33.0	3.0	0.0	1.4	1.3	12.7
TOTAL	**149,990**	**27,857**	**128.0**	**9.0**	**8.0**	**19.4**	**5.0**	**34.4**

Source: CFE/Subdirección de Distribución/Unidad de Electrificación.

Despite its growth, only a few companies are participating in this market, in large part because Condumex has 95% of the market, at least for public sector projects. Condumex, which has won most of the competitive bids for PRONASOL projects (usually solicited at the state level), recently won a $5 million bid for photovoltaic applications in the troubled state of Chiapas. The federal government is making a concerted push to win supporters in Chiapas, and photovoltaics are part of this effort. Condumex buys almost all of its modules from Siemens (U.S.) and some from Solarex (U.S.). Since NAFTA went into effect, Condumex no longer buys from Kyocera (Japan), which used to enjoy a significant market share. As one of Mexico's leading electronics suppliers, Condumex also manufactures and supplies all auxiliary components for these systems.

Photovoltaic applications have also been used extensively in Mexico's telecommunications sector in recent years. When Mexico's only phone company, Teléfonos de México (TELMEX), was privatized, investors agreed to a program of improving service in rural areas as part of the privatization effort. This has driven TELMEX purchases of small-scale remote solar power systems for rural relay devices and pay telephones, a market that has mushroomed in the last few years.

U.S. Solar Technology at a Mexican Resort

During the winter of 1992, diesel bills at the El Cid Mega Resorts in Mazatlan were reaching $700/day to heat five pools covering over 3,716 m^2. Here, an innovative U.S. system is offsetting this huge cost while helping to meet the hotel's hot water needs.

In January 1993, Aquafauna Bio-Marine of Hawthorne, California recommended a non-glazed Heliocol 335 m^2 system. In March 1993, the system was installed atop the Granada Hotel. Based on local diesel costs (26¢/liter), the Heliocol system is expected to have a payback of less than 18 months. Due to the success of the first installation, an additional 1,672 m^2 of panels are planned.

Source: *Solar Industry Journal*, Fourth Quarter 1993, Volume 4, Issue 4.

USAID, the GEF, and the Mexican Government are providing a stimulus in the intermediate/small-scale renewable energy market. USAID's contribution is the three-year, $4 million Mexico Renewable Energy Project, which is designed to reduce global warming by funding various renewable energy projects in Mexico. The project's goals are to promote sustainable economic development in rural areas where electricity is lacking and enhance protected areas by utilizing renewable energy systems to provide basic services such as communications, lighting, and water supply to reserve and park facilities and to poor and indigenous communities within the surrounding buffer zones. Renewable energy systems are being selected using least-cost criteria on a system life-cycle basis. This project is emphasizing demonstration systems for social and private productive use applications, particularly water pumping, an application not emphasized by PRONASOL.

The growth of intermediate hybrid or stand-alone wind systems has been limited to an ad hoc market. These applications simply have not been getting the push that small photovoltaics have received, although a few successful systems have been installed in recent years in Oaxaca, Zacatecas, Quintana Roo, and other locations. Sales in the micro-hydro market have lagged despite the strong potential for this technology, even in the irrigation systems in dry, northern Mexico.

Hybrid Village Electrification Systems in Mexico

The fishing village of Xcalac, on the east coast of Quintana Roo, has had intermittent power from diesel systems for years. The systems required frequent maintenance, the fuel supply was unreliable, and Xcalac was often without power.

Electrification through an extension of the utility grid would have required the construction of 110 kilometers of power lines. Because of the high cost, such a project would not have been pursued in the near future. In response to repeated petitions from the Xcalac people, the state government hired Condumex in November 1991 to study the feasibility of providing the village with reliable electric power from renewable energy. In August 1992, Condumex completed the construction of a new hybrid system.

Electricity demand was originally estimated at 160 kWh/day. The 240-volt, three-phase system would provide approximately 400 Xcalac residents with power for residential use and streetlights. With technical assistance from Bergey Windpower and the American Wind Energy Association, Condumex designed a hybrid power system that included six 10 kW wind turbines from Bergey Windpower, an 11.2 kW photovoltaic array from Siemens Solar Modules, and the existing diesel generator. This system is the largest of its kind in the Americas and has been 100% available during the first year of operation.

The total cost was around $450,000 (including shipping, tariffs and installation), compared to $3.2 million estimated by the public utility for a grid extension. The approximate equipment costs to replicate this project are shown below.

Estimated Equipment Costs to Replicate the Xcalac System

Quantity	*Unit Size*	*Description*	*Cost (US$)*
6	10 kW	Bergey BWC-Excel Wind Turbines	128,000
240	47 watt	Siemens M-75 Modules	88,000
1	35 kW	Existing Diesel Generator	n/a
38	12 V	GNB Battery Modules	70,000
1	40 kW	Advanced Energy Systems Static Inverter	55,000
1	-	Condumex Supervisory Controller	3,000
-	-	Miscellaneous Equipment	21,000
-	-	Instrumentation	4,000
		TOTAL	369,000

Excerpted from: *Small Wind Energy Systems Applications Guide* Case Studies, American Wind Energy Assn., 1993.

5.3 BEST OPPORTUNITIES

Several opportunities will arise in 1995-1996 as developers find ways around regulatory constraints, as the constraints themselves diminish, and as costs come down for some new technologies. Utility-scale supply projects will be driven in part by the CFE expansion plan (Exhibit 5-5).

Exhibit 5-5
CFE Capacity Additions
(1994 - 2003)

Resource	MW
Combined Cycle	6,425
Dual (Coal and Fuel Oil)	700
Hydroelectric	3,467
Fuel Oil	2,458
Coal	700
Geothermal	213
Nuclear	675
TOTAL	14,639

Source: CFE.

Large Hydro

CFE has a list of potential future hydro projects (Exhibit 5-6). These projects have either already passed through the feasibility study phase or the studies are now being conducted. Additional captive power opportunities will exist for private power developers with innovative approaches to getting around Mexican regulatory constraints.

Large Captive Wind

Specific opportunities for large wind projects will build on the Energía Nuevo Leon cogeneration project (see Chapter 4: Energy Efficiency), where state and municipal governments were brought into the project as minority shareholders to make it primarily a self-sufficient, captive power project. Municipal lighting electricity rates on the order of 6-10 cents/kWh will establish strong municipal, county and state interest in these projects. Where this interest coincides with the wind resource and sales to CFE are approved, some projects will go forward. If CFE can be convinced of the demand-side management benefits of these projects (which could, in some cases, reduce coincident peak lighting demand), prospects will improve.

Exhibit 5-6
CFE Hydro Projects in the Feasibility Study Phase
(1994)

Project	State	Capacity (MW)	Average Annual Generation (GWh)
El Cajón	Nayarit	750 (3 x 250)	1630
La Parota	Guerrero	765 (3 x 255)	1332
Alexcaco	Puebla	120 (3 x 40)	336
Eq. El Gallo	Guerrero	60 (2 x30)	167
Copanalá	Chiapas	240 (3x 80)	680
Soyopa	Sonora	50 (2x 25)	195
Arroyo Hondo	Jalisco	170 (2 x 85)	366
Eq. Trojes	Jalisco	8 (2 x 4)	41
La Ciudad	Durango	110 (2 x 55)	240
Eq. Togomil	Jalisco	18 (2x9)	42
San Francisco	Jalisco	328 (2x 164)	716
Xúchiles	Veracruz	225 (3x 75)	653
Omitlán	Guerrero	135 (3x45)	321.5
TOTAL		2979	6719.5

Source: CFE.

The greatest wind resources are in the Isthmus de Tehuantepec in southernmost Mexico; as mentioned earlier, states with significant wind resources include Oaxaca, Quintana Roo, Zacatecas, Michoacán, Baja California, Hidalgo, Coahuila, and Guerrero. Pacific Northwest Labs will be completing a wind resource assessment that will assist developers who are pursuing this market.

Large Biomass

USAID is identifying bankable project opportunities for U.S. industry through its Mexico Biomass Cogeneration Development Program. These will capture a percentage of Mexico's estimated 54 million metric tons of crop residues and forest products industry biomass waste. Targeted waste streams include sugarcane and sawmill residues. Apart from these opportunities, there is also potential for large captive-power projects using advanced tree plantation technologies as a fuel supply supplement.

CHAPTER 6
FIXED-SOURCE AIR POLLUTION CONTROL

Key Market Segments

Large Industrial Sources
Medium/Small Industrial Sources
Fuel Switching

Air pollution is often seen as the worst environmental problem facing Mexico's largest cities. It is estimated that the health effects of air pollution cost Mexico City alone at least $1.5 billion each year in lost economic productivity. These and other air pollution concerns have led the Mexican Government to launch numerous projects over the last few years to combat air pollution, particularly in Mexico City. The Metropolitan Commission for Pollution Prevention and Control in the Valley of Mexico (CMPCCAVM) has made progress in collaborating with PEMEX and other government entities to control pollution.

Mexico's chief urban pollutants include unburned hydrocarbons, ozone, particulates, nitrogen oxides, sulfur dioxides, carbon monoxide, lead and airborne toxics. In the past, emissions have reached 11,700 tons daily in Mexico City alone. In 1991, fixed sources made the following contributions to Mexico City's air pollution:

- 3% carbon monoxide
- 25% nitrogen oxide
- 47.5% hydrocarbons
- 21.8% sulfur dioxide
- 2.1% particulates.

This characterization helps explain the Mexican Government's emphasis on fuel switching and fuel oil desulfurization as measures to abate pollution in industry, bringing nitrogen oxide and sulfur dioxide levels down dramatically.

In 1993, INE surveyed industries in several Mexican cities to determine emissions levels of particulates, sulfur dioxide, carbon monoxide, nitrogen oxides, and unburned hydrocarbons. The results of this survey show that the highest concentrations of heavily polluting facilities are located in Salamanca and the Tula/Vito/Apaxco corridor, where many of Mexico's petroleum refineries are located, and in the Toluca/Lerma lake region in the State of Mexico.

6.1 MARKET ESTIMATES

The market for air pollution control equipment and services is expected to reach $456 million in 1996, posting an average growth rate of 10% per year from 1993 to 1996 (Exhibit 6-1). Most of the business will be in retrofitting existing boilers for natural gas utilization and the purchase of new, clean burning units. The overall air pollution control market is believed to have contracted in 1994 (during this election year, authorities appear to have slackened enforcement in the key air pollution market of Mexico City). With the change of administration and the implementation of NAFTA, some parts of the market are expected to be revitalizated in 1995 as industry begins to compensate for "lost time" in 1994.

Exhibit 6-1
Air Pollution Control Market Estimates*
(millions of US$)

Segment	1993	1994	1995	1996	Average Annual Growth 1993-1996
Monitoring Equipment	15.0	15.0	15.0	17.0	4%
Air Testing Services	0.8	0.4	0.5	0.7	5%
Pollution Abatement Equipment	18.0	15.0	15.0	18.0	0%
Natural Gas Retrofit Equipment	306.0	330.0	370.0	420.0	11%
TOTAL	339.8	360.4	400.5	455.7	10%

*Does not include mobile source testing and emissions control..

The authors have assumed that 75 monitoring units were installed in 1993 at an average cost of $200,000 and that volume fell in 1994 to 40 units. Air testing services, a new market, is believed to have reached 75 firms, each with five stacks at a cost of $2,000 per stack in 1994. Pollution abatement equipment does not show the kind of volume that might be expected if the purchase of scrubbers were a major component of this market. Industry representatives in Mexico have indicated that firms rarely purchased scrubbers in 1993 and 1994; and in 1992 CFE (the national electric utility) accounted for most of the scrubber market. Instead, most of the market in

Mexico is for cyclones (at an average cost of $70,000) and baghouses (at an estimated average cost of $250,000). Approximately 75 cyclones and 50 baghouses were thought to have been sold in Mexico in 1993.

Although the exact number of companies that have purchased natural gas retrofit equipment and new clean-burning boilers is not known, in 1993 the numbers were estimated to have reached 1,600 and 300, respectively. At an average cost of $50,000 per retrofit and $750,000 per boiler, this represents a $300 million market in 1993.

The DOC estimates that 25 air pollution instrument and equipment manufacturers and 70 distributors and services firms are currently active in the Mexican market. European and Japanese companies present formidable competition in this market, especially when they bring financing to the table, as is often the case. However, the United States has generally dominated the air pollution control market with a 64% share. Germany has approximately 18% of the market, Japan 10%, Canada 4% and others 4%.

Several factors will play a role in driving growth in the air pollution control market in the years ahead:

- ***Improvements in the economy.*** Economic recovery in Mexico will be a major factor in generating the resources needed for private sector investment.

- ***Fuel switching.*** Switching to natural gas as a combustion fuel source will become increasingly important as a low-cost compliance alternative for large industrial facilities.

- ***More enforcement.*** Enforcement will increase in Mexico City as economic and demographic growth contribute to increasing air pollution problems, even as solutions are implemented.

- ***New legislation.*** Mexico City will be implementing its own environmental legislation, which could establish stricter compliance standards than federal requirements.

- ***Tariffs.*** NAFTA provides U.S. suppliers a tariff advantage over competition from outside North America.

In contrast, other factors will act to constrain the growth of this market in the coming years:

- ***Competing investments.*** Investments that enhance productivity and competitiveness will continue to take precedence over air pollution control investments.

- ***Non-technical solutions to pollution.*** Mexican cities will be solving an important share of their particulates problems without pollution abatement technologies. For example, Mexico's Northern Border Project, with partial funding from The World Bank, will be paving roads as a major anti-particulates measure. In Monterrey, quarries are being required to move further outside city limits as a major particulates control measure.

- ***Market saturation.*** Important segments of the market will be reaching saturation, including:

  - *The market for air monitoring networks for municipalities.* Cities like Mexico City, Guadalajara, Monterrey, and Torreón have already had their systems installed by companies like Tijuana Equilibrio Ecológico (a Chem Waste company) in Guadalajara, Abengoa/Saincomex (a Spanish/Mexican joint venture) in Torreón, and Radian Corporation/Radian de México (an Austin, Texas-based firm) in Mexico City and Monterrey.

  - *The steel industry.* This industry already invested heavily air in pollution control equipment in 1992.

  - *Very large companies.* Many of these, especially multinational companies in the major cities, have already been forced to invest in monitoring and treatment equipment. The exception is PEMEX, which continues to lag behind despite the strong efforts of its principal counterparts in the electric power, steel, cement, and automobile industries.

6.2 MARKET PERFORMANCE: 1992 TO 1994

Mexico has made some important strides in controlling fixed-source air pollution over the last few years. For example:

- extensive air pollution control standards are now in place
- fuel prices are up, reducing emissions throughout Mexico
- the three largest cities now have automatic monitoring networks

- natural gas is now widely used at power plants and other facilities in metropolitan Mexico City
- desulfurization plants will be providing cleaner fuel oil in the near future.

As of December 1991, the sale of high-sulfur fuel oil was prohibited in Mexico City and replaced with an alternative with 33% less sulfur (*gasoleo*). CFE's power plants in the metropolitan valley now burn 96% natural gas, and at least 365 major companies have also switched to natural gas. Natural gas is now a major part of the country's anti-pollution strategy (see box).

The Natural Gas Boom in Mexico

Mexico is increasingly relying on natural gas to mitigate local pollution in major cities and along the border. Natural gas is particularly attractive because the alternative is often fuel oil with 5% sulfur content. PEMEX estimates that natural gas demand will grow at 7-10% per year through the year 2000. Growth in demand will probably be highest in northern Mexico, which has ready access to U.S. supplies, most of which come from Texas.

Much of Mexico's demand will have to be met by U.S. suppliers. Mexican natural gas is usually associated, and tight budgets at PEMEX limit gas exploration in favor of oil exploration. Mexico also has a limited natural gas distribution network.

Growth in consumption is being fueled in part by CFE; the utility has already switched many of its power plants over to natural gas. These include virtually all units in the Mexico City metropolitan area, and others in Durango, Jalisco, Nuevo Leon, Hidalgo and Veracruz. Many new projects planned in the near term, like Mérida III in the Yucatan, will also be natural-gas fired plants because they are economical and clean.

But even CFE accounts for only 17% of Mexico's natural gas consumption. PEMEX is the largest user, burning 44% of the 3.6 billion cubic feet per day used in Mexico. PEMEX uses gas as a fuel and as an input into some of its petrochemical production processes. Other industries in Mexico account for 35% of consumption, and the rest (4%) is for the residential sector.

Growth is also being spurred by more rational pricing policies that are removing the price differential between natural gas and fuel oil. PEMEX does, when necessary, drop fuel oil prices far enough to compete with natural gas and preserve market share.

Source: *Business Mexico.*

These measures have resulted in major drops in sulfur and lead content in Mexico City's air and represent a significant advance over a very short time. Unfortunately, even the combustion of

cleaner fuels contributes to the formation of ozone, which is now Mexico City's principal air pollution problem.

In the fixed-source market, air monitoring companies like Thermo Environmental/Leeds & Northup de México had the most success during 1992-1994. Sales of wet scrubbers (i.e., by Wheelabrator Air, Environmental Elements) were not as successful because Mexican steel and other companies chose less costly options such as baghouses. Neither did U.S. firms looking to establish mobile emissions laboratories (i.e., Hart Crowser, CH_2M Hill) make much progress during 1992-1994. U.S. technology has suffered from lack of financing or from more competitive financing packages by European and Japanese competitors. This has been especially true in the sale of baghouses, cyclone technology, monitoring equipment including mobile laboratories, and energy-efficient burners.

NAFTA has partially levelled the playing field by giving U.S. equipment lower customs duties, but that advantage is only now beginning to develop. Some Mexican companies are paying on the order of $250,000 for continuous stack emissions technology. In this case, a 10% NAFTA tariff advantage could amount to $25,000.

During 1992-1994, the country's largest air pollution regulation offenders were the first to buy monitoring, fuel switching, and stack pollution abatement equipment. U.S. multinationals throughout the country were targeted for compliance as a response to U.S. criticism of Mexico's environmental record during the pre-NAFTA debates beginning in 1992. These companies, which include General Motors and Gillette, were also thought to be best able to pay for compliance measures. The biggest offender in Mexico City, Cementos Anáhuac, a Mexican cement company, was forced to implement measures, as was its counterpart, Cementos de México (Cemex) in Monterrey. Other segments that saw activity in the air pollution market were newly privatized companies, companies with International Finance Corporation (IFC) equity participation (i.e., certain subsidiaries of large Mexican conglomerates like DESC and Grupo ALFA), and companies that have had very visible local air emissions impacts either on the border or elsewhere in Mexico, such as the Cananea copper smelter operations on the U.S.-Mexico border.

Mexico also made progress in eliminating chlorofluorocarbons (CFCs) during 1992-1994. In the summer of 1994, The World Bank provided $1.6 million to NAFINSA and SEDESOL to begin projects designed to eliminate 2,000 tons of CFCs over the next 15 years. Dow Chemical is one U.S. company that is active in this segment, expecting to sell $3 million worth of a new service that offers alternative technologies for ozone-depleting agents. Mexico is the only original Latin American signatory to the Montreal Protocol that is not itself immediately affected by ozone depletion.

Selected Companies Active in the Mexican Fixed-Source Air Pollution Control Market	
U.S. Firm	**Mexican Rep/Distributor**
American Air Filter	Purificación de Aire Mexicana
Atlas Electric Devices	Equipar
CM Kemp Manufacturing	Avante Ingenieros
Cole Palmer	Distribuidores y Representaciones Heru
Croll Reynolds	NA
Dionex	Productos Tecnoquimicos, Durubier Rosales
FARR	Filtration Systems de México
Parkson	NA
Pura Fil	Purificación de Aire Mexicana
Radian Corporation	Radian Mexicana
Thermo Environmental	Leeds & Northrup Mexicana
Westinghouse Environmental	Schultz
VWR Scientific	NA
Whellabrator Air/Altec	NA
Equipment Origin	**Mexican Distributor**
Germany	AF Snyder General de México
Various European	Asea Brown Boveri de México
Germany, Japan, France	Internacional Cientifica
Germany	Beckman de México
Germany, Japan, France, Canada	Casa Mario Padilla
Germany, France	Harry Mazal
Germany, Japan, Canada	Equilec
Japan, France, Canada	Equipos e Instrumentos
Source: USDOC.	

6.3 BEST OPPORTUNITIES

Some specific opportunities may arise with companies seeking third-party financing from banks such as the IFC. These firms include:

- ***Mexicana de Cobre (Mexcobre).*** This copper mining firm has a 76% equity stake in Mexcananea, which operates the Cananea copper smelter on the U.S. border. As an extension of its analysis of Mexcobre's environmental compliance, the IFC has recommended that Mexcananea improve air quality monitoring, both in the

workplace and in the surrounding environment, and install particulate collection equipment to reduce concentrations of stack emissions.

- ***Sigma***. This food processing company will be installing boilers in new facilities designed to comply with governmental requirements and World Bank guidelines for stack emissions.

- ***Grupo IRSA (GIRSA).*** This diversified chemicals company is modernizing its Altamira carbon black plant to include post-combustion of the tail gas from the chemical reactors and heat recovery. Chemical reactors, fuel burning equipment, and product handling equipment at the Altamira plant are required to comply with air emissions standards.

Many of the companies on the Mexico City Valley list of 50 worst offenders have yet to comply with air emissions standards (Exhibit 6-2). If enforcement is stepped up in 1995-1996, these companies will need to make investments in pollution control equipment and services.

Opportunities may also stem from The World Bank-funded Ozone Protection Program for Mexico under the Montreal Protocol. About $1.6 million will be spent over 15 years to fund CFC-elimination projects at six companies and one government agency (Exhibit 6-3).

Fuel switching to natural gas will continue to be a major market in regions with access to natural gas transmission and an urgent need to reduce emissions. Besides Mexico City, which has already made much progress in this area, northern Mexico is a good candidate, especially because natural gas imports from the United States are available. In 1994, for example, the Electricity Generating Board in northern Mexico will replace all residual fuel oil consumed in fired boilers with natural gas.

Opportunities may exist in capturing emissions from cement plants that are planning to burn hazardous wastes. These include several Cemex and Anahuac facilities. See Chapter 3 on Solid and Hazardous Waste for more details on this potential market.

Exhibit 6-3
Ozone Mitigation Projects for Mexico
(1994 to 2018)

Project	Funding
Centralized Reprocessing of CFC 113 and Methyl Chloroform at Química at Omega	$295,302
Centralized Reprocessing Plant for CFCs, HCFCs at Quimobásicos	$222,615
Recuperation of Refrigerants at Climas Jimenez	$252,246
Recuperation of Refrigerants at Quimobasicos	$ 30,690
Pilot Refrigerants Management, Conservation, and Recuperation Project at the Instituto Mexicano de Seguro Social	$499,918
Commercial Refrigerants substitution of CFC-12 with HFC 134a at Refrigeracion Omega	$225,000
Elimination of CFC 113 in the Cleaning of Eyeglasses at Styloptic	$ 79,299
Total	**$1,605,070**

Source: Sierra International Inc.

Exhibit 6-2
The Fifty Worst Offendors in Mexico City, 1992

Firm	Industry Type	UTE*	Firm	Industry Type	UTE *
1. Anáhuac	cement	37500	26. Vidrio Plano de México	glass	1923
2. Fábrica de Papel Sal Rafael	paper	24516	27. Fábrica Nacional de Vidrio	glass	1855
3. Cía. de Papeles Industriales	paper	7658	28. Química Henkel	chemical	1734
4. Fibras Sintéticas	textile	7245	29. Cartón United	paper	1713
5. Fábrica de papel de México	paper	6759	30. Cervecería Modelo	food and beverage	1584
6. Procter & Gamble de México	chemical	6197	31. Vidriera México	glass	1540
7. Kimex	textile	5839	32. Cajas Corrugadas	paper	1520
8. Vidriera Oriental	glass	5779	33. Eternilita	ceramics	1473
9. Silic. y Derivados	ceramics	4059	34. Manufacturas Gargo	paper	1419
10. Papelería Iruña	paper	397	35. Uniroyal	tires	1216
11. Papelería Atlas	paper	3543	36. Vidrio Plano	glass	1207
12. Sosa Texcoco	ceramics	3423	37. Texlamex	textile	1182
13. Loreto y Peña Pobre	paper	3379	38. Cryoinfra	chemicals	1031
14. Industrias Conasupo	food and beverage	3339	39. Transformadora de Acero	metal	941
15. Madrueño y Compañía	paper	3041	40. Frascos de Ac. Cent.	glass	886
16. Pape El Fénix	paper	2521	41. Productos Mundet	glass	886
17. Vidriera Los Reyes	glass	2500	42. Kraft General Foods de México	food and beverage	886
18. Fábrica de Papel Coyoacán	paper	2348	43. Polímeros	chemicals	875
19. Fábrica de Jabón La Corona	chemical	2302	44. Química Borden	chemicals	865
20. Fábrica de Papel San Rafael	paper	2095	45. Aceros Nacionales	metal	863
21. Cartonajes Estrella	paper	2042	46. Arancia Glucosa	chemicals	862
22. Fábrica de Papel de Santa Clara	paper	2027	47. Seda Real	textile	811
23. Acabados Río Blanco	textile	1996	48. Acabadora de Textiles	textile	811
24. Empaques Modernos San Pablo	paper	1959	49. Hako Mexicana	chemicals	804
25. Fábrica Nacional de Vidrio	glass	1936	50. Industrias CH	machinery	800

Source: Departamento del Districto Federal.
UTE = Unidad de Toxicidad Equivalente (Units of Toxic Equivalents) -- a pollution indicator that combines a number of criteria pollutants: SO_2, NO_x, CO_2, and VOCs.

CHAPTER 7
ENVIRONMENTAL CONSULTING

Key Market Segments

Environmental Audits
Environmental Impact Assessment

The Mexican environmental consulting market ranges from geological and hydrological surveys to wastewater treatment plant designs. Consulting/engineering services have a long history in Mexico, and include wastewater treatment plant designs for large installations in both the public and private sectors, environmental audits, and environmental impact assessments. New regulations and critical events like the sewer explosions in Guadalajara have also spurred the development of a market for environmental risk assessment and management.

7.1 MARKET ESTIMATES

The market in Mexico for environmental audits and impact assessments is expected to reach $22.5 million by 1996 (Exhibit 7-1). This market, which contracted significantly in 1994, is expected to recover strongly in 1995 as the backlog of studies required in 1994 is performed in 1995. Also, legislation in some states that requires environmental audits in all high-risk industries is expected to be effected in 1995, helping to spur growth in this market.

Conversations with U.S. companies in Mexico indicated that approximately 200 audits were performed in Mexico in 1993 at an average cost of $50,000 each, and that this volume dropped by half in 1994. About 500 environmental impact assessments were thought to have been performed in 1993 at an average cost of $25,000 each.

Several factors will contribute to the growth of the environmental consulting market, as well as the market share of U.S. environmental consulting firms:

- ***Industry education programs***. Mexican industry associations are launching programs to educate their members on the technical requirements and costs associated with various types of environmental consulting services. The

Exhibit 7-1
Environmental Consulting Market Estimates
(millions of US$)

Segment	1993	1994	1995	1996	Average Annual Growth 1993-1996
Environmental Audits	10.0	7.5	8.5	10.0	2%
Environmental Impact Assessment	12.5	10.0	11.0	12.5	1%
TOTAL	**22.5**	**17.5**	**19.5**	**22.5**	**2%**

chemicals industry is the most aggressive in this regard because it is classified as "high risk" and will increasingly come under government scrutiny.

- ***Consulting market maturation***. The maturation of the Mexican environmental consulting market over the next two years will have a positive impact on the U.S. market share. Specifically, as INE begins to check more carefully the environmental impact assessments performed in 1993-1994 before renewing authorization to conduct such studies for 1995-1996, firms that fail to produce an acceptable product may be removed from the market.

Factors that will constrain growth include:

- ***Lack of consulting experience***. The continued unfamiliarity in Mexico with using environmental consultants will hinder the growth of this market.

- ***Sole sourcing of consultants***. As the operations of multinationals in Mexico have come under intense scrutiny, many subsequently hired qualified firms, even at U.S. labor rates, to perform technically sound analyses that would stand up to Mexican Government review. In general, these firms will continue to use the same consultants. While this is not a growth constraint *per se*, it will limit the entry of new players in some instances.

- ***Reliance on Mexican sole-proprietorships***. In general, the practice of hiring foreign specialists to perform studies is a new trend. Potential Mexican clients have suffered "sticker shock" when looking at the costs of using U.S. environmental consulting/engineering services. The result has been the tendency of Mexican clients to turn instead to sole proprietors for the performance of certain required environmental studies such as environmental impact assessments. In the past, a number of these independent consultants performed studies of unsatisfactory quality, many of which were contracted in the absence of strict government or industry guidelines. Because manufacturers were generally unfamiliar with the requirements of these studies, few could distinguish between a satisfactory and unsatisfactory product. This is gradually changing as INE exerts greater effort in the area of quality control.

  Despite this reliance on sole-proprietorships, a number of foreign consulting firms have attempted to enter the market in the past few years. However, only a handful of these companies have succeeded or have made the long-term commitment to establish roots in the Mexican market. These companies have not escaped the economic uncertainties and cost restructuring that have rippled throughout the economy in recent years.

7.2 MARKET PERFORMANCE: 1992 TO 1994

Federal regulations requiring environmental impact assessments (EIAs) for new construction projects in Mexico have driven the market for EIAs. According to the provisions of the 1988 General Ecology Law, EIAs are required for new projects in the following sectors: agriculture and forestry, fishing, power, mining, tourism, public works, communications, transport, chemicals, petroleum refining, steel, pulp and paper, sugar, beverages, cement and automobile manufacturing.

Selected Companies Active in the Mexican Environmental Consulting Market

Abengoa/Saincomex
AguaConsult
Black & Veatch
Booz, Allen & Hamilton/Booz, Allen & Hamilton de México
Bufete Industrial Ingeneria Ambiental
Camp Dresser & McKee
CH_2M Hill
Consultants' Group Latin America
Cydsa/Atlatec
Delcam/Planigrupo
Dorr Oliver/Dorr Oliver de México
Eco-Ingenieria
Eco-Interamericana
ERM/ERM de México
David Evans & Associates/Costo Racional Asesores
S.A. Garza Engineers
HBT Agra
ICF Kaiser/ICF Kaiser de México
Industrial Ecology International
Instituto Autonomo de Investigaciones Ecologicas (INAINE)
InternationalDyncorp Meridian/Dyncorp Latin America
Jones and Neuse/ABC Estudios y Proyectos
McDermott/Babcock & Wilcox International/B&W Mexicana
Ralph M. Parsons/Latinoamericana de Ingenieria
PEMEX/Instituto Mexicano de Petroleo
Radian/Corporación Radian
Rust International
Sistemas Hidráulicos y Ambientales (SIHASA)
Technoconsult
USX/UEC Environmental Systems
Roy F. Weston/Weston International
WMX/Ingenieros Civiles Asociados (ICA)
Woodward-Clyde/Woodward-Clyde de México
World Environment Center/WEC de México

INE has been the entity responsible for drafting EIA guidelines, evaluating EIAs submitted by project developers, and maintaining a register of consulting firms authorized to conduct the studies. During 1988-1992, the number of EIAs reviewed by INE jumped from 22 to 396 (Exhibit 7-2). From January 1993 through September 1994, INE received 2,174 EIAs for review. Nearly 60% of these studies related to projects in the states of Tamaulipas, Chiapas, Mexico, Tabasco, Campeche, Sonora, and Veracruz and over 50% were EIAs for projects by PEMEX or CFE.

PROFEPA has also a initiated a program of voluntary industrial audits, which has contributed to the growth of the consulting market (Exhibit 7-3). This program is described in greater detail in Chapter 1.

In terms of competition, the biggest change in the consulting market during 1992-1994 was the increase in the number of U.S.-Mexican joint ventures and environmental consulting subsidiaries. These include Corporación Radian, ABC Estudios y Proyectos (now a Jones & Neuse subsidiary), ICF Kaiser de México, and Dorr-Oliver de México. These companies have made the commitment to invest in developing the Mexican market and enjoy the advantage of low Mexican labor rates combined with U.S. technical expertise.

Exhibit 7-2
Growth of EIAs in Mexico by Sector

Year	Agriculture	Fisbing	Electric Power	PEMEX	Mining	Tourism	Urban Development	Industry	Communications and Transport	TOTAL
1988	8	0	3	0	2	4	0	5	0	22
1989	7	108	8	3	2	25	0	18	8	179
1990	157	49	121	14	18	71	4	86	8	528
1991	176	37	163	67	32	59	0	242	3	779
1992	3	3	96	14	12	75	6	158	29	396

Source: Instituto Nacional de Ecologiá, SEDESOL, 1992.

Regulatory Requirements for New Facility Development in Mexico

Before construction can begin on a new industrial facility in Mexico, an environmental impact assessment must filed with INE. If the manufacturer considers its operations to be non-polluting, a preventive statement must be filed. If the facility or the proposed production process is deemed risky under the government's listing of high-risk industries (such as chemical/petrochemical production), then a risk assessment study must also be performed in addition to the environmental impact study. These studies can only be conducted by an outside engineering firm that is permitted and licensed by INE.

Once the EIA and other necessary documents are submitted, local authorities grant permission to construct. Before actual operation can begin and during future operations, additional information, prepared by consultants, may be required. This includes:

- air emissions analysis
- air emergency contingency plans (Mexico City)
- atmospheric emissions inventory
- hazardous waste generator's manifest
- analysis of residual water discharges
- verification that stored hazardous wastes are compatible.

Source: Market Strategies International.

Exhibit 7-3
Companies Participating in PROFEPA's Audit Program as of June 30, 1994

Company	Convenio* Negotiated	Audits in Progress	Audits Completed	TOTAL
Grupo Cementos Mexicanos		9	9	18
Ferrocarriles Nacionales de México			19	19
Grupo Peñoles		14		14
General Motors		56		56
PEMEX		20	3	23
Nestle	5	1		6
Industrias Luismin	4			4
Grupo Azucarero México			4	4
Cementos Apasco	4	1		5
Others	138	46	87	271
TOTAL	151	147	122	420

* *convenio* = agreement with PROFEPA to participate in an audit program
Source: PROFEPA.

7.3 BEST OPPORTUNITIES

Specific consulting opportunities in air, water, solid/hazardous waste, remediation and energy are discussed throughout this report and are tied to projects and trends, including multilateral bank loans, privatizations, and projects sponsored by the U.S. Trade and Development Agency. The following are some of the best general consulting opportunities in this market over 1995-1996:

- ***Municipal services***. The trend toward the privatization of municipal services is opening up opportunities for consulting firms, ranging from wastewater treatment plant design to site assessments for sanitary landfills.

- ***Water***. The new policy of charging companies for water consumption and contaminant discharge is spurring a market for water-use minimization consulting services.

- ***Hazardous wastes***. As the enforcement of hazardous waste regulations increases as disposal sites are developed, the demand for waste minimization services will increase to offset the cost of disposal.

- ***Air pollution***. Continued air pollution problems in major cities will drive the demand for consulting services designed to enable companies to burn fuel more efficiently with or without natural gas.

- ***Energy management***. The recent rises in electricity tariffs have begun to spur some initial demand for energy management services.

EIAs and environmental audit activities will increase steadily. Companies wishing to pursue this market should go through the INE registration process to be placed on the list of certified consulting firms.

CHAPTER 8
REMEDIATION

Key Market Segments

Industrial/Site Remediation
Storage Tank Services
Municipal Landfill Remediation
Emergency Spill Response

The remediation market is the least documented environmental market in Mexico. There are as yet no regulations or guidelines covering the remediation of contaminated sites. Likewise, no inventory of contaminated sites exists and there are no clear rules on liability. While opportunities in this market are limited in the near term, certain segments could experience significant growth in the coming years.

Industrial/site remediation. This market covers projects for state-owned and private companies, and companies currently undergoing privatization. Mexico's state-owned companies have some potentially staggering cleanup projects. PEMEX (the state oil company) is probably the worst offender; CFE (the national utility) and the state-owned railroad company, Ferrocarriles Nacionales de México (FNM), are also likely candidates for future remediation projects. Most of the information on opportunities in the state-owned segment, however, is anecdotal because companies like PEMEX do not allow third parties to assess their sites; even Mexico's environmental agencies are reported to have limited access to PEMEX data and facilities.

Storage tank services. The cleaning and upgrading of storage tanks, both underground and above-ground, as well as the remediation of contaminated tank sites is another important market segment. Gasoline storage tanks at PEMEX's 3,000 gas stations throughout Mexico suffer chronic leakage problems. The number of industrial storage tanks that require cleaning and remediation services is even greater. The improper disposal of lubricants is also a major problem in Mexico. According to one expert interviewed for this study, 800 million liters of lubricants are dumped every month in Mexico, equivalent to an Exxon Valdez oil spill every 30 days.

Municipal landfill remediation. The remediation of unsecured municipal landfill sites where hazardous wastes have been improperly disposed of constitutes another important market segment. Currently, 97 municipal landfills are operating in Mexico; many of these will be closed

during 1995-1996 and replaced with modern facilities meeting the 1995 regulations for landfill construction and operation.

Emergency spill response. This market constitutes services designed to rapidly contain and clean up chemical and oil spills as soon as they occur. These spills periodically happen in Mexico, although the precise number of such events is not known. Since the sewer system explosions in Guadalajara in the summer of 1992, Mexican firms, including PEMEX, are more sensitive to the possible hazards of uncontrolled spills. This increased sensitivity has helped to stimulate the market for emergency spill response services.

8.1 MARKET ESTIMATES

The Mexican market for environmental remediation, emergency spill response, and tank cleaning services is expected to reach $78.5 million in 1996. Overall, this market is expected to grow 17%, on average, between 1993 and 1996. Site remediation will be the largest share of this market and will generally comprise a limited number of private-sector cleanup efforts and related analyses. Under less vigorous government pressure during a presidential election year, this market did not expand at the expected rate and it is likely that it will not see very fast growth until the appropriate legislation and related regulations are put in place. This may not occur until after 1996.

The market for emergency response is not believed to have slowed in 1994 as major companies, especially PEMEX, have now become seriously concerned over the public relations impacts of oil and chemical spills. This market is expected to continue to grow at about 20% as these corporate concerns increase in Mexico.

Tank cleaning and replacement services is another market that could see growth in range of 21%, on average, between 1993 and 1996. Services tend to be driven by an interest in resource recovery and replacement by intense government pressure following the sewer explosions in Guadalajara.

Some of the factors that will drive growth in this market include:

- ***Remediation work required for privatization.*** The continued privatization of state-owned industrial assets will open up additional possibilities for the site assessment and remediation work required prior to ownership transfer. During the first nine months of 1993, 14 state companies were auctioned off. At the end of 1993, 50 of the remaining 209 parastatals were in the process of being sold, liquidated, merged or transferred to state governments. Among the corporations on the auction block were Almacenes Nacionales de Deposito (ANDSA, a system of state-owned grain warehouses) and Pipsa, the state-owned newsprint maker

which supplies half of Mexico's newsprint needs. Additional sales of secondary petrochemical plants owned by PEMEX will take place once world market prices for secondary chemicals recover.

Exhibit 8-1
Remediation Market Estimates
(millions of US$)

Segment	1993	1994	1995	1996	Average Annual Growth 1993-1996
Site Remediation	10	11	12.5	14.5	13%
Emergency Response	5	6	7.2	8.7	20%
Tank Services	3	3.6	4.4	5.3	21%
TOTAL	18	20.6	24.1	28.5	17%

- ***Public awareness***. The outcry in neighborhoods contaminated by leaking gasoline, compounded by a nationwide fear of a repeat of the 1993 Guadalajara gasoline/sewer explosions, should open up the gas-station segment of the storage tank market.

Constraints on this market's growth will include:

- ***Lack of liability guidelines***. Mexico does not yet have guidelines on liability, so it is not clear who must pay for remediation in many cases.

- ***Competing investments***. Remediation projects will compete against compliance-driven water, solid waste and air projects for a share of limited environmental budgets.

Additionally, several interrelated factors will limit the potential for doing remediation work. PEMEX is passing through a periord of critical restructuring to make it competitive. This comes at the same time that the company is facing higher marginal costs for oil exploration and

extraction now that the most economic reserves are exhausted. Simultaneously, it is being called upon to build multi-million dollar desulfurization plants and unleaded gas refineries while boosting natural gas production. Capital shortages are thus limiting other environmental initiatives. FNM and CFE present a different scenario. These companies, unlike PEMEX, will be opening to private capital participation over the near term (FNM) or over the medium to long term (CFE).

Despite the limited near-term opportunities, several companies are currently active in pursuing this market. For example, the hazardous waste management joint venture between Eco-MetalClad and Química Omega will be remediating the "El Confín" hazardous waste disposal site in San Luis Potosí before modernizing and operating the new facility.

Selected Companies Pursuing the Mexican Remediation Market

Company	*Market Segment*
Bechtel	Industrial/Site Remediation
David Evans	Industrial/Site Remediation
Deter Saneamiento	Storage Tank Services
Foster Wheeler	Industrial/Site Remediation
Groundwater Technologies	Industrial/Site Remediation
ICF/Kaiser	Industrial/Site Remediation
Levine-Fricke	Storage Tank Services
MetalClad/Química Omega	Industrial/Site Remediation/Storage Tank Services
SIPASA	Landfill Remediation
Weston International	Industrial/Site Remediation

8.2 MARKET PERFORMANCE: 1992 TO 1994

The most active segment of this market in 1992-1994 was newly-privatized companies and foreign acquisitions. Agreements to undertake site remediation have sometimes been made a pre-requisite for purchase or remediation before investors could participate.

Because of increasing media attention and public outcry, the state-owned segment made some (albeit slow) progress during the last few years. PEMEX can no longer clean tanks and dump the residues in lagoons. It also has signed a cooperative agreement with SEDESOL, and is now quick to remediate new spills, although progress on past spills is minimal.

Recent experience shows that Mexico's enforcement agencies are lax on new spills and policing other government agencies. This was the case in a major chemical spill off the Pacific coast of Mexico, where PROFEPA was slow to take action until many fisherman in the area had already

suffered what appeared to be acid-related burns. Also, an FNM spill in early 1994 resulted in little immediate action. Numerous anecdotal cases exist of PEMEX not being held responsible for spills on land and water along the Gulf coast and southern Mexico.

The storage tank business also showed little movement until 1994. Gas stations in major cities are aggressively replacing leaking tanks as a risk reduction measure. Because of neighborhood complaints of gasoline leaks, some cities are beginning to negotiate agreements with local gas station owners for the installation of double-lined storage tanks.

8.3 BEST OPPORTUNITIES

The best opportunities will be in projects that involve the participation of international agencies, such as the IFC, IDB, or World Bank, which are now required to include environmental provisions in their major infrastructure development projects. An opportunity may exist with the upcoming World Bank/FNM Mexico-Railway Restructuring Project, designed to open the Mexican railway system to private capital and transform it into a commercial operation. This project will rely primarily on private capital, estimated at $1.64 billion during 1994-1999. The World Bank will provide $100 million in financing to support the project. Under this project, environmental audits of railway workshops and fueling stations will be conducted prior to privatization. An environmental master plan will also be completed. According to The World Bank, FNM will be responsible for the effects of past contamination, but the concessionaires will be responsible for any new problems. While no specific site remediation projects appear to have been identified, there could be good opportunities in the future.

Other potential opportunities will come from The World Bank-funded Mexico Second Solid Waste Management Project, discussed in Chapter 3. This project includes a component to fund the closure of unsecured municipal landfills. As part of the $384.7 million equipment and services component, the project will fund leachate drainage and treatment, gas control systems, and monitoring wells.

A longer-term opportunity related to the Northern Border Environmental Project is the remediation of two sites, one in Tijuana containing several thousand tons of used lead batteries and another in Mexicali, where organic solvents are stored for recycling. The remediation of these sites, however, will be part of a follow-on project beginning in 1997.

Opportunities may also exist in the storage tank market. PEMEX is interested in recovering those residual storage tank wastes that can be sold. Furthermore, the demand for double-lined storage tanks for PEMEX gas stations is growing as environmental regulations begin to touch this segment. The first concrete opportunities will be in Monterrey, where an agreement has been reached between the city and gas station operators on modernizing storage tanks following a serious leak.

CHAPTER 9
SOURCES OF FINANCING FOR ENVIRONMENTAL INVESTMENTS IN MEXICO

The Mexican Government has made great strides towards creating mature financial markets, beginning with the privatization of the national banking system in the late 1980s. Its most recent action has been the automation of the Bolsa de Valores (the Mexican stock exchange).

The availability of financing will be a key determinant in the success of environmental and energy projects. Although key developments in the banking and securities markets and in public sector finance have increased the availability of short-term credits and have begun to address the shortage of longer-term investment capital, the costs of trade and investment financing are still reasonably high. This chapter presents a brief overview of major developments in Mexican financial markets during 1992-1994 and outlines the current options for both trade and investment financing for municipal and private sector environmental projects.

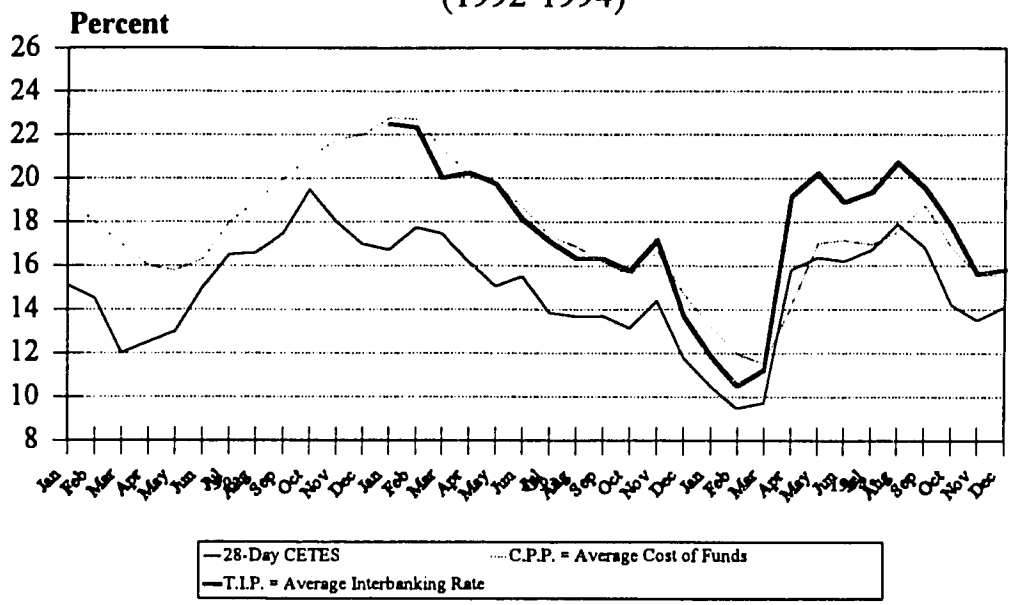
9.1 RECENT DEVELOPMENTS IN MEXICAN FINANCIAL MARKETS

During 1992-1994, Mexican financial markets operated in an environment of increasing macroeconomic stability, especially with regards to exchange and interest rates. The Mexican New Peso (peso) weathered two crisis periods in 1992-1994, which were associated with pre-NAFTA uncertainty and the assassination of ruling party presidential candidate Luis Colosio. It survived because investors held confidence in the economic policies of the Mexican Government and kept dollars flowing in. Economic events in December 1994 suggest that the exchange markets may remain somewhat more volatile during the beginning of the new presidential administration. Long-term stablility will be dependent on a number of internal spending cuts, tighter monetary policies and investment-driven tax policies of the Government of Mexico. Direct exhange rate support activities of the U.S. Treasury like the $6 billion credit line already in place to support the peso must be supplemented with additional multilateral agencies (e.g., the NADBank) that direct capital into specific areas of the economy.

Mexican interest rates remained comparatively high through mid-1994 because of the exchange rate volatility, political uncertainty, and the rise in U.S. interest rates. However, short-term interest rates (28-day treasury rates, or CETES) declined from a high of 103% in 1987 to a low of around 16% (Exhibit 9-1). This trend is likely to be interrupted by pressures to maintain higher interest rates in reaction to spot declines in exchange rates and higher U.S. interest rates.

However, the long-term direction of interest rates could stabilize if the government is able to reassure foreign investors and continue to attract foreign capital. The Government of Mexico's challenge is to create a politically stable environment with policies designed to attract both domestic and foreign capital into a broader business base created through the sale of government assets and strict environmental compliance regulations that will stimate growth in a larger number of environmental service companies.

Exhibit 9-1
Mexico Nominal Interest Rates
(1992-1994)



• Forecast from July 1994
Source: Grupo Financiero Bancomer.

Commercial Banking

To attract new capital and promote competition and efficiency in the banking system, the Mexican Government authorized 20 new banks during 1993. Forty-seven new applications from foreign banks have been approved or are currently awaiting approval. There were also several important mergers during 1992-1994 that promoted regional competition and allowed banks to achieve greater economies of scale. Expanded competition in the banking sector, combined with an increase in the productive economic base through tax policies and foreign investment that encourages expansion in a larger number of smaller growth companies, may make credit available to borrowers on more favorable terms. Additionally, it could increase the number of new credit instruments including securitization, derivatives, and non-recourse project financing

(including privatization financing) to local joint ventures supported by creditworthy foreign partners.

A less positive development in the banking sector was the dramatic 130% real increase in overdue loans during 1993.[1] Experts trace this to two major factors: borrowers' financial difficulties during the economic downturn and Mexican banks' lack of credit analysis expertise after they were privatized in the late 1980s and released from their government lending requirements. While Mexican development banks have stepped in to meet some of the excess demand, they too, have seen a real increase of 53.3% in their overdue loans.[2] To tackle this problem, the Bank of Mexico, Finance Ministry, and National Banking Commission have tightened their regulatory supervision; likewise, the banks themselves have implemented stricter loan qualification standards and begun to develop automated credit information systems. This more cautionary approach, however, is not expected to outweigh the benefits from increased competition in the banking sector.

Public Sector Finance

The Government of Mexico has committed itself, through the Pact for Stability, Competitiveness and Employment (PECE), to fiscal spending targets set in 1993. Furthermore, the Salinas Administration financed public spending through fiscal surplus instead of Central Bank credits. By doing so, it expected to have a balanced budget in 1994, despite the planned increase in social spending (education projects in particular) to reactivate the economy.

To counter the new restrictions on public spending, state and local governments are seeking a greater role for private investors in the development of municipal infrastructure. In particular, Mexican Government agencies are turning increasingly to build-operate-transfer (BOT), operating concessions, and similar arrangements to develop municipal water and wastewater treatment projects. Several early examples have indicated that many of these privatization schemes will require increases in user fees and changes in government tax policies to be successful. Temporary or even longer-term state or federal guarantees for shortfalls in user payments may be required by developers to make such programs financially viable.

Municipal bonds will eventually be used to finance large infrastructure projects, although this is contingent on major changes in the tax code (municipalities and states are currently unable to borrow funds directly). Over the next five to ten years, the strongest states (e.g., Nuevo Leon,

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1 Overdue loans as a percentage of total loans remained around 8%.

2 U.S. Embassy Mexico, *Economic and Financial Report-- Winter 1994.*

Sonora) will pioneer the development of municipal bond markets. In the meantime, private bond financing through Ecosys (see Chapter 3) and other holding companies will be more common.

Capital Markets

The Mexican securities market, the Bolsa de Valores, has undergone intense growth in the last ten years. While the capitalization value of the market was around 7% of GDP in 1985, it currently exceeds 45%, primarily as the result of several large issues including the Telmex (the national phone company) issue in 1993. There are currently around 60 companies traded on the exchange; Telmex accounts for 30% of the total market value.

During 1992-1994, the stock index experienced considerable volatility associated with the passage of NAFTA. The market also broadened and deepened as a result of key regulatory reforms and a greater role for foreign investors. Important revisions were made to regulations governing a range of financial intermediaries, including the securities market, banks, credit unions, insurance companies, and bonding companies. The major objectives of these revisions were to open the market to increased competition from foreign financial institutions, trim excessive regulation, and promote domestic savings. The Mutual Funds Law was revised in late 1992 to facilitate the formation of more specialized funds. A new type of financial intermediary, the limited objective finance company, was authorized and permitted to raise funds by issuing its own securities and lending to specific economic sectors. To date, at least five limited objective finance companies have been organized for the consumer and small/medium company sectors.

The 1992-1994 period also saw the formation of an intermediate, or second-tier market of the Mexican Stock Exchange. The second-tier market officially began operations in July 1993. It gives companies that do not meet the capitalization and marketability requirements of the first-tier market access to equity capital.

Despite these considerable steps, Mexican capital markets are still in the relatively early stages of development. More viable options for project finance in the near term may be government-sponsored infrastructure finance institutions such as BANOBRAS or The World Bank (see program descriptions below) or BOT-type arrangements. CFE (the national utility), for example, has been able to obtain nearly $2.5 billion of investment financing to construct 3,000 MW of new power generation facilities through build-lease-transfer (BLT) arrangements. These transactions are structured like turnkey construction contracts with a medium- to long-term payout under lease agreements. BOTs are emerging as a viable financing option for wastewater treatment projects in particular.

9.2 SOURCES OF FINANCING

A number of Mexican and foreign financial intermediaries are active in Mexico in the area of trade and investment finance. These institutions offer the following types of general services to both private and public borrowers:

- trade financing
- project financing
- insurance
- development bank programs including infrastructure support.

Several of these institutions also have programs that are targeted at environmental and energy conservation projects; Exhibit 9-2 presents a list of the most active in this area.

Exhibit 9-2
Financial Institutions Active in the Mexican Environmental Market

Type of Financial Intermediary	Institution
Export Credit Agencies	Export-Import Bank of the U.S. Japan Export-Import Bank U.S. state export agencies
Commercial Banks	Mexican commercial banks U.S. and foreign commercial banks
Development Banks	BANOBRAS NAFIN World Bank Inter-American Development Bank North American Development Bank
Project Finance	U.S. and foreign investment banks International Finance Corporation Interamerican Investment Corporation
Equity Investors	Mexican development trusts North American Environmental Fund

Export Credit Agencies

The Export-Import Bank of the United States (Ex-Im Bank). Ex-Im Bank is active in Mexico in all of its major service areas: direct loans, long-term guarantees, and short- and medium-term

export credit insurance. Ex-Im Bank's *1993 Annual Report* rates Mexico as having the largest concentration ($763.1 million) of gross loans outstanding of all the countries with which it does business, second only to Brazil, which has $1.2 billion in outstanding loans. Mexico is Ex-Im's largest customer; approximately one fifth of all Ex-Im's foreign exposure is to Mexico.

Export-Import Bank of the United States
General Programs for U.S. Exporters and Foreign Buyers

Guarantees

- working capital guarantees through U.S. commercial lenders for U.S. exporters
- medium- (2-5 years) and long-term (5-10 years) guarantees for fixed or floating rate export loans from U.S. or foreign lenders to foreign buyers of U.S. exports

Loans

- competitive fixed-rate direct loans to foreign buyers of U.S. exports

Insurance

- export credit insurance for short- and medium-term sales by both regular and U.S. small business exporters (per U.S. Small Business Administration definition)
- export credit insurance for financial institutions against losses on irrevocable letters of credit issued by foreign banks on behalf of foreign buyers of U.S. exports or on short-term loans to foreign buyers of U.S. exports
- operating and financing lease insurance

Ex-Im Bank recently launched an Environmental Exports Program to improve the competitive position of U.S. environmental companies in targeted high-growth markets, including Mexico. The program will support $800 million in U.S. environmental exports in 1994, a 100% increase over the bank's 1993 contribution. Furthermore, the program will aggressively use Ex-Im Bank resources to offset foreign concessionary financing offers for environmental projects. It includes:

> enhanced environmental export insurance policies providing short-term and multi-buyer coverage for small business environmental exporters

- enhanced[3] medium- and long-term support for environmental projects, equipment and services
- market-specific financing packages, the first of which is the Mexican Municipal Wastewater Finance Initiative.

The BANOBRAS/Ex-Im Bank of the United States Mexican Municipal Wastewater Finance Initiative

In April 1994, Ex-Im Bank announced a new initiative. It will provide $500 million to support BOT projects in the municipal wastewater treatment sector. Specifically, Ex-Im Bank and BANOBRAS will provide a backup source of repayment to lenders in case user fees collected by municipalities for wastewater services are inadequate to cover project debt service. It is reported that the initiative is a counter-response to recent offers by the Japanese Export-Import Bank to fund wastewater treatment facilities in Mexico at rates of 1-2% for long-term notes.

Role of Key Participants

BANOBRAS	*Ex-Im Bank of the U.S.*
▸ contingent revolving line of credit to municipalities to ensure payment to project operators/lenders	▸ repayment guarantees to U.S. and Mexican commercial banks for financing U.S. export component of projects

In addition to the new wastewater program, Ex-Im Bank provides credit lines and project financing for large borrowers such as CFE and PEMEX. In mid-1994, Ex-Im Bank committed to provide $350-400 million in financing for CFE's 750 MW gas-fired Samalayuca electricity generation plant. Ex-Im Bank also operates a bundling program or credit guarantee facility, through which it has approved certain Mexican commercial banks as acceptable borrowers of one- to five-year dollar credits. Credits are available for up to 18-month drawdown periods. Buyers can approach Mexican banks to off-lend these funds to Mexican buyers under $10 million without specific Ex-Im Bank approval. Mexican banks participating in Ex-Im Bank's bundling program include BANCOMEXT, Nacional Financiera, Banamex, and Banca Serfin.

Many Mexican commercial banks are unable to provide dollar funding for medium- and long-term loans. Actual funding for trade credits comes from Ex-Im Bank directly or, more commonly, from a commercial bank with U.S. dollar funding sources, such as a U.S. commercial bank, or a foreign bank operating in the United States. When Ex-Im Bank does not

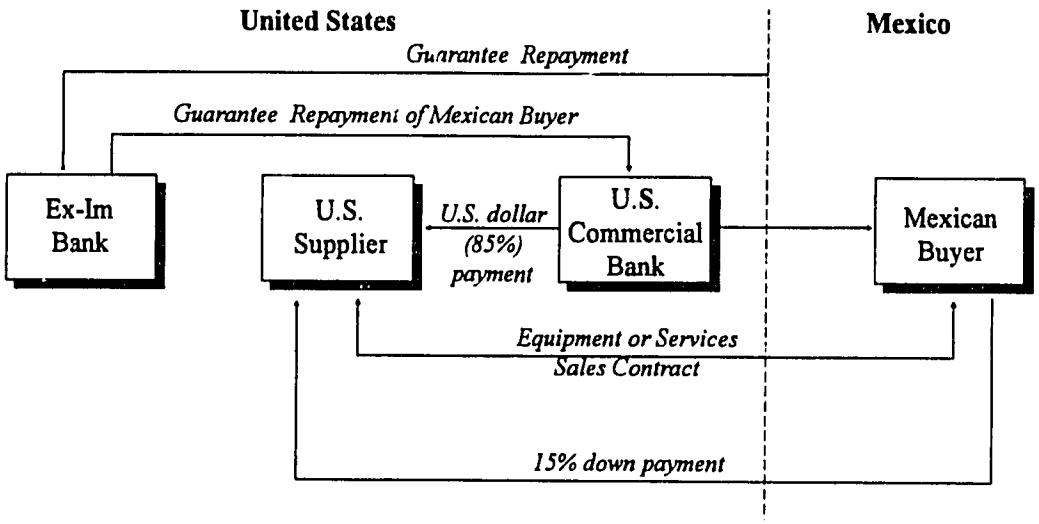
[3] Enhancements include local cost coverage up to 15% of the U.S. content contract price, capitalization of interest during construction, and maximum allowable repayment terms under OECD guidelines.

provide funds, it provides a repayment guarantee to the financial institution that provides the funding. Ex-Im Bank recommends guarantees versus direct loans because guarantees are a more timely product. Below is a list of the parties involved in organizing Mexican buyer credits and a diagram of a typical arrangement among them (Exhibit 9-3):

Mexican buyer: PEMEX, CFE, private Mexican companies (the buyer must rely upon its own credit-worthiness to purchase U.S.-manufactured products using export credit agency credits).

U.S. supplier: U.S. manufacturer or developer planning to procure U.S. equipment or services (the U.S. supplier must make the sale to the Mexican buyer, and encourage the Mexican buyer to use its own credit to make the purchase).

Exhibit 9-3
Buyer Credits Under Ex-Im Bank Guarantee Program



Notes: Under a direct credit, Ex-Im takes on added role of U.S. commercial bank

Ex-Im works with some large buyers, such as PEMEX. Instead of a Mexican commercial bank guarantee, Ex-Im receives a Ministry of Finance guarantee.

Funding source: A financial institution with dollars (usually a bank in the U.S. including U.S. banks and foreign branches such as Swiss Bank, Barclays Bank and others, but in the case of direct loans, can be Ex-Im Bank). The funding source makes a loan to the buyer or to a Mexican bank that on-lends the funds. The funding source receives a repayment guaranty from Ex-Im Bank.

Mexican guarantor: If a Mexican buyer does not meet Ex-Im's credit criteria, a Mexican commercial bank guarantees the repayment of the Mexican buyer.[4] The beneficiary of the Mexican bank guarantee is Ex-Im Bank.

In order to arrange financing for their export sales, it is recommended that exporters consult with U.S. and Mexican banks that have already completed transactions through the Ex-Im Bank.

Japan Export-Import Bank (Jexim). Jexim is planning a $500 million loan program to support the development of Mexican companies. The first activity under this program consists of a $200 million line of credit to the Mexican development bank NAFINSA for loans to small- and medium-sized businesses in and around Mexico City to finance productivity improvements and pollution control investments. This is the first dollar-denominated credit line granted to a Mexican institution by an international credit agency for a 10-year term. Furthermore, it is the first facility of its kind that is not tied to exports from the lending country (unlike the Ex-Im Bank of the U.S. facilities). In addition to this new facility, Jexim has provided $1.8 billion in concessional, untied financing for Mexican institutions including PEMEX and SEDESOL.

State Export Finance Agencies. A number of U.S. state governments provide assistance to local exporters. For example, the California Export Finance Office provides loan guarantees up to 90% or $1.5 million for accounts receivable financing. It also extends revolving credit to exporters. Information on such programs is usually available from the state economic development agency.

Commercial Banks

Mexican banks. Mexican banks provide direct credit lines in pesos, and sometimes in U.S. dollars, to Mexican and U.S. companies with established track records in Mexico. If the company is a U.S. subsidiary new to the market, its U.S. bank may need to guarantee the loan with a standby letter of credit issued by its Mexican counterpart bank. Some Mexican banks can also provide foreign exchange coverage to Mexican and foreign-owned companies for up to one year, as authorized by the Bank of Mexico. Devaluations compared to contract reference rates are refunded to investors at contract maturity. The central bank requires the reference rate to be the 48-hour floating rate established two days before contract maturity. The costs of covering foreign exchange risk can be substantial.

[4] For large projects, Ex-Im Bank has the capability to evaluate transactions on a project finance basis or limited recourse basis, in which there is no requirement for a sovereign or Mexican bank guarantee.

It is important for U.S. companies to establish long-term relationships with Mexican commercial banks. It is recommended that U.S. companies research the competitive terms at both commercial and development banks in Mexico.

U.S. and foreign banks. Several U.S. commercial banks are still active in Mexico, although many (both large and small) will no longer provide loans to Mexico. Many banks lost money from the successive debt reschedulings of the 1980s and the 1990 debt-relief agreement, called the Brady Plan, which was concluded under the direction of the U.S Treasury Department, the IMF and The World Bank. The Brady Plan was favorable for Mexico, but it left many U.S. banks with large write-offs. Japanese commercial banks were also losers. Although Citibank and a few others made commitments to continue lending new money, most U.S. banks opted for a lower level of funding and better collateral. This is changing, however, as banks seeking to obtain branch charters (such as the Bank of Boston) are increasing their lending as a condition of obtaining a license.

As a result, foreign commercial banks are funding only short-term interbank transactions or loans guaranteed by export credit agencies. Some short-term letters of credit are available for established importers. Commercial transactions that generate foreign exchange are also more readily financed. Commercial banks are willing to accept hard currency accounts receivable as collateral security on loans, and in some cases where larger Mexican borrowers were involved, have securitized such receivables. Other exports transactions can be financed through advanced export payment facilities where the pre-purchase of an exportable commodity or service provides adequate repayment facilities. U.S. commercial banks that are still active in Mexico include Citibank, Chase Manhattan, Morgan Guaranty, First Interstate Bank, Bankers Trust, Bank of Boston, Chemical Bank, and Bank of America.

Development Banks

Banco Nacional de Obras y Servicios Públicos (BANOBRAS). BANOBRAS is Mexico's official infrastructure lending institution. It is an active borrower from The World Bank, and is currently a primary executing agency of The World Bank-funded Water Supply and Sanitation, Solid Waste, and Northern Border Environmental Projects, all of which involve major infrastructure development procurements.

BANOBRAS is adapting to increased private participation in municipal infrastructure by providing guarantees that municipalities will pay for services, or allow billing and collection, for private water and sewerage projects (see Ex-Im Bank-BANOBRAS Mexican Municipal Wastewater Finance Initiative described above). Simultaneously, BANOBRAS is working to strengthen the municipal management of infrastructure projects by demanding better operational and financial performance as a lending condition.

BANOBRAS provides short-term loans for public works projects against contractors' receivables from the government agency financing the project; it is widely believed that this practice has spurred the development of the Mexican construction industry.[5] BANOBRAS also operates a special trust fund that can provide up to 25% of the total cost of a project to finance construction start-up costs.

BANOBRAS has been active in lending for environmental projects. It currently focuses its environmental public works lending in four categories:

- drinking water and sewer systems in urban areas
- road and transportation systems in medium-sized municipalities
- solid waste remediation and industrial waste treatment: BANOBRAS has facilitated the creation of specialized investment teams to assist in the construction of plants able to treat domestic and industrial wastes
- Energy Conservation and End-Use Efficiency Program: BANOBRAS is financing the replacement of light bulbs in public lighting systems with high-capacity, high-efficiency bulbs, as well as the installation of monitoring systems.

Nacional Financiera (NAFINSA). NAFINSA was the Bank of Mexico's parastatal company until 1989, when it shifted its focus to small- and medium-sized industry (majority Mexican-owned). NAFINSA is an active borrower from The World Bank. Some World Bank funds are borrowed on behalf of parastatal borrowers (CFE, FNM) and some for onlending to commercial banks and small- and medium-sized commercial and industrial enterprises.

In recent years, NAFINSA has become active in environmental lending. It currently has a $245 million loan program to finance water and energy conservation projects. Around one-third of the funds go to projects in Mexico City, while 20% goes to the border states. The following categories of projects are eligible:

- acquisition and installation of pollution control equipment or retrofitting of existing equipment
- construction of industrial waste (liquid and solid) treatment plants
- acquisition and installation of water and/or energy conserving technologies
- studies, technical assessments and training relevant to the above criteria
- investment capital.

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[5] World Bank, *World Development Report 1994: Infrastructure for Development*, June 1994.

Peso financing for small and medium-sized companies is available at long-term preferential rates (Exhibit 9-4). The rates are those offered by the NAFINSA intermediary to borrowers. These companies typically face nominal rates of 30-32% on commercial bank loans.

Exhibit 9-4
NAFIN Environmental Lending Program - Terms and Conditions Loan

Loan Category	Fixed Rate	Variable Rate	Term/Grace Period
Technical Assistance	16.5%	CPP+4	5 years/12 months
Machinery and Equipment	16.5%	CPP+4	10 years/12 months
Installations	16.5%	CPP+4	12 years/18 months
Studies and Assessments	16.5%	CPP+4	5 years/12 months
Share Capital	16.5%	CPP+4	7 years/24 months

CPP = *costo promedio porcentual* (average cost of funds for Mexican banks), CPP+4 was 21.18% in June 1994.
Source: NAFIN, 1994.

Borrowers under the NAFINSA program include industrial, commercial, and service enterprises, investors, municipalities, and states. The program is available to Mexican organizations only. In addition to equipment, financing may be requested for training and technical assistance, studies and consulting fees, and commercial and service activities. NAFINSA intermediaries include (by percentage of total NAFINSA funds retailed): credit unions (40.5%), factoring companies (32.1%), commercial banks (23.2%), leasing companies (2.3%), and development funds (1.8%).[6]

NAFINSA also provides equity funding and loan guarantees for environmental projects. The bank has a $175 million allocation for equity investments in joint ventures in the environmental technology field. It also offers a 50% automatic loan guarantee for environmental technology

[6] NAFINSA, *Mecanismos de Financiamiento para Proyectos Ecologicos*, 1994.

development projects, and additional guarantees of up to 85% of the project cost for small companies and 70% for large companies.

The World Bank. The World Bank is an important source of financing for the Government of Mexico and state-owned industries. Although total World Bank lending to Mexico has decreased from $2.7 billion in 1989 to $1.3 billion in 1992 and $680 million in 1993[7], its financing for environmental and energy projects in Mexico has been substantial (Exhibit 9-5).

Exhibit 9-5
World Bank Energy and Environmental Loans to Mexico 1990-1994

Date Approved	Name of Project	Executing Financial Agency	World Bank Loan ($ millions)
4/90	Electricity Transmission and Distribution	CFE/NAFIN	450
11/90	Water Supply and Sanitation	CNA/BANOBRAS	300
4/92	Mexico Environmental Project	SEDESOL/BANOBRAS	50
2/92	Atmospheric Contamination	ZMCM/NAFIN	220
6/94	Norther Border Environmental Project	SEDESOL/BANOBRAS	368
6/94	Water Supply and Sanitation II	CNA/BANOBRAS	350
6/94	Solid Waste	SEDESOL/BANOBRAS	200

Source: U.S. Department of Commerce Mexico City estimates, July 1994

Most of these loans are matched by equal or greater contributions from the Mexican Government; some, like the Water Supply and Sanitation II Project, are co-financed by the Inter-American Development Bank as well (see description below). The loan for the $50 million Mexico Environmental Project went primarily towards strengthening environmental regulations, as well as the management and administration of SEDESOL's environmental programs. Most of the remaining loans, on the other hand, were used to finance the procurement of civil works, equipment and consulting services for wastewater treatment plants, municipal solid waste landfills, and a range of other environmental infrastructure and pollution control applications.

[7] U.S. Department of Commerce Mexico City estimates, July 1994.

Procurement under World Bank-financed projects is facilitated through a variety of bidding practices:

- *International competitive bidding* is used for procurements over $1 million and is designed to provide all bidders with equal opportunities to compete. Preference may be given to Mexican manufacturers or service providers; in the past, CFE and other Mexican firms have restricted their sources of procurement to local suppliers and have permitted international competitive bidding only when no Mexican company could do the job. The World Bank has encouraged CFE to open up its procurement practices to international competitive bidding.

- *Limited competitive bidding* is international competitive bidding by direct invitation (without open advertisement), and may be preferred for smaller contracts when there are a limited number of qualified suppliers.

- *Local competitive bidding* is competitive bidding advertised only in Mexico; foreign firms may participate in this form of bidding when they form a joint venture with a Mexican firm. To date the, foreign winners in local competitive bidding include Degremont, U.S. Filter, Biwater, and Severn Trent in the water sector and Bechtel and Valero Energy in the power sector.

- *International and local shopping, and direct contracting* do not require bidding. Shopping is used when quotations are accepted from several foreign or local suppliers. Direct contracting without competition may be used to extend contracts when specific equipment is required in order to be compatible with existing equipment, or when competitive bidding fails to deliver an acceptable bid.

Procurement notices and contract awards are published regularly for both The World Bank and Inter-American Development Bank in the *Development Business* journal published twice a month by the United Nations Department of Public Information in New York City.

Inter-American Development Bank (IDB). As with World Bank loans, most IDB funds are matched by contributions from executing agencies of the Mexican Government. Exhibit 9-6 lists the major IDB environmental and energy projects funded during 1990-1994. Several of these are co-financed by The World Bank; the Water Supply and Sewerage Program, for example, is the IDB component of The World Bank-supported Water Supply and Sanitation Sector Project.

IDB's regional water sector projects (e.g., the Monterrey and Guadalajara projects) present good opportunities for U.S. suppliers of wastewater treatment equipment and services; these are described in greater detail in Chapter 2.

The most recently approved IDB loans to Mexico include the Loss Reduction and Energy Conservation Project and the Multisector Global Credit Program. Both projects were in the identification stage in July 1994. The first project consists primarily of measures to reduce electricity losses from CFE's transmission and distribution lines, and strengthening CFE's organizational structure and management system. The second will be a line of credit for small and medium companies to modernize production and adapt to international competition. Clean production energy conservation investments will most likely be eligible for financing.

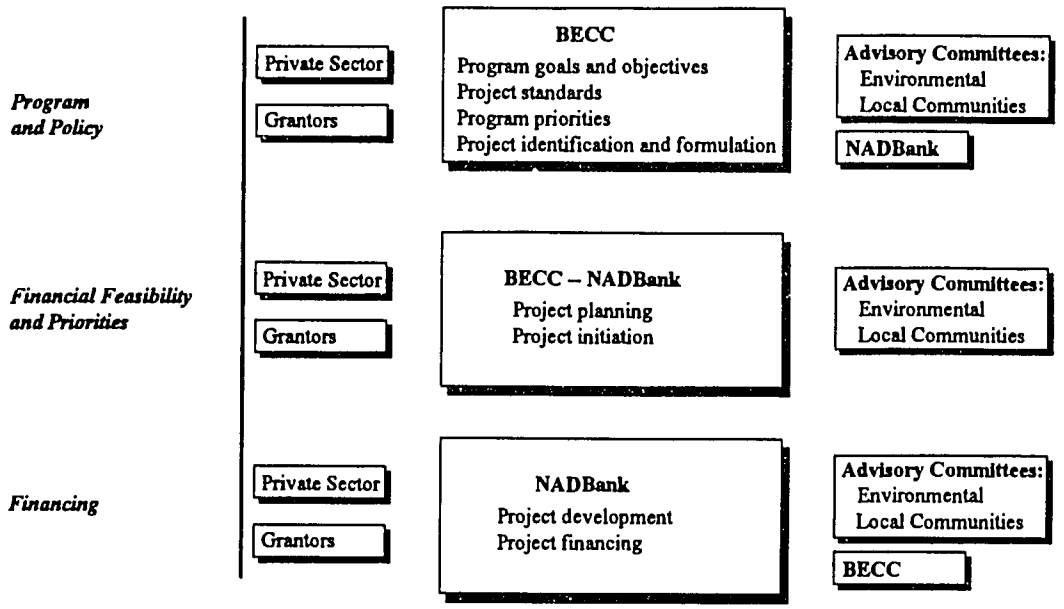
Exhibit 9-6
Inter-American Development Bank Energy and Environmental Loans to Mexico, 1990-1994

Date Approved	Name of Project	Executing Financial Agency	World Bank Loan ($ millions)
6/90	Program of Investments in the Electric Sector	CFE	330
11/90	Monterrey IV Potable Water and Sanitation	Servicio de Agua y Drenaje de Monterrey/CNA/BANOBRAS	325
1/92	Water Supply and Sewerage Program	CNA	200
4/94	Guadalajara Potable Water and Sewerage	Sistema Intermunicipal de Agua y Alcantarillado Guadalajara	300
7/94	Loss Reduction and Energy Conservation	CFE	250
7/94	Multisector Global Credit Program	NAFIN	500

Source: Inter-American Development Bank.

North American Development Bank (NADBank). In parallel with the implementation of NAFTA, the Mexican and U.S. Governments are establishing the NADBank to finance water infrastructure projects along the U.S.-Mexico border. These projects must be certified by the Border Environment Cooperation Commission (BECC), which was established under NAFTA. NADBank will also provide financing, as endorsed by the Mexican or U.S. Governments, for community adjustment and investment in support of the NAFTA provisions. The bank will supplement private investment when capital is not available on reasonable terms. Project support may take the form of guarantees, credit enhancements, letters of credit, buy-back arrangements, loans, and equity participation. Exhibit 9-7 depicts the institutional arrangement between the BECC and NADBank.

Exhibit 9-7
North American Development Bank (NADBank) -Border Environment Cooperation Commission (BECC) Institutional Arrangement



Source: NADBank, Board of Directors Meeting, San Antonio, June 1994.

The NADBank is expected to make a total of $2 billion in loans and guarantees, with an upper limit of $3 billion. The U.S. and Mexican Governments will each contribute $225 million every year for four years. It is anticipated that private funds will bring the total capitalization to $2-3 billion by 2000. The bank is currently planning lines of credit for environmental projects. In fact, its officials estimate that around 90% of the bank's total capitalization will go towards water and wastewater treatment projects along the U.S.-Mexico border.

The board of directors has established the following general eligibility criteria for NADBank financing. Eligible projects must:

- induce or enhance social and economic development in the region
- preserve, protect and enhance the environment in the border region
- provide sufficient information for ongoing project monitoring
- be certified by the BECC
- meet the bank's expected rate of return (to be determined by the board based on risk profile and internal profitability goals).

Additionally, NADBank's participation must not replace any existing financing sources.

The NADBank board of directors aims to have its operational staff functioning by October 1, 1994 when its first tranche of capital becomes available. The bank will be headquartered in San Antonio, Texas.

Project Finance

U.S. and foreign investment banks. To date, only a small number of U.S. and foreign banks provide project finance services in the Mexican environmental market. In June 1994, Chase Manhattan Bank closed the first limited recourse financing for an environmental project in Latin America. The project involves the construction, operation and maintenance of the Chihuahua North wastewater treatment facility to serve the State of Chihuahua. The project developer is Atlatec, the environmental services subsidiary of the Mexican fiber and chemicals conglomerate, Cydsa. Chase has arranged $9 million, 8½ year financing for the project, which will be supplemented by $5.4 million in financing from the municipal water authority, Junta Municipal de Agua y Sanamiento de Chihuahua, and equity financing from local private investors. Chase hopes to replicate this arrangement for dozens of potential similar deals with Mexican municipal water authorities.

Banque Paribas (France) is another foreign bank that has been active in this area. In general, European banks are more visible than U.S. banks in the area of environmental project finance in Mexico. Financing for large water supply and wastewater treatment projects with British engineering firm involvement, for example, is typically arranged by British commercial banks.

The International Finance Corporation (IFC). The IFC is The World Bank division that finances private sector investments. It has long been active in the Mexican industrial sector, funding up to 25% of development projects through equity participation or lending. IFC credits are long term, and are made at commercial fixed and variable rates in U.S. dollars and other hard currencies. In early 1994, the IFC entered the Mexican environmental sector with its decision to take equity participation in a wastewater treatment plant in Puerto Vallarta (Jalisco). The British firm Biwater is also providing equity capital for this project.

The Inter-American Investment Corporation (IIC). The IIC is a new private-sector oriented bank affiliated with the Inter-American Development Bank, which will provide medium- to long-term loans and equity investments to private companies in Mexico and other Latin American and Caribbean countries. The IIC plans to focus primarily on lending to small and medium-sized companies. Environmental projects in Mexico will likely become part of this new bank's lending portfolio during 1995-1996.

Equity Investors

Mexican development trusts (fideicomisos). *Fideicomisos* are a unique mechanism for leveraging NAFINSA, public sector and private funds for investment in Mexico. There are 17 *fideicomisos* in Mexico City alone, including the Fondo de Investigación y Desarrollo para la Modernización Tecnológica (FIDETEC), which specializes in investments that promote technology development. Several *fideicomisos* provide concessional financing explicitly for environmental and energy efficiency projects; a good example is the Fideicomiso Jalisco (FIDEJAL). FIDEJAL (Exhibit 9-8) was created in 1989 by President Salinas to promote private investment in public works and services in the state of Jalisco. The principal contributors are the Government of the State of Jalisco, NAFINSA, Promotora Promex, and Fomento y Promoción de Jalisco (a private state development corporation). Banco Promex is the fiduciary. A technical committee oversees management of the trust, which is conducted by a general director with a small secretariat.

Exhibit 9-8
Status of FIDEJAL Environmental Projects as of July 1994

Project	Status
Concession for the collection and final treatment of waste for the municipality of Puerto Vallarta	On hold
Concession for the construction and operation of an industrial non-hazardous waste disposal facility	Awaiting passage of state regulation
Concession for the construction and operation of an industrial hazardous waste disposal facility	Currently being marketed
Authorization for the incineration and confinement of hospital wastes in the Guadalajara Metropolitan Zone	Under study
Installation of an air quality monitoring network in the Guadalajara Metropolitan Zone	In progress
Jalisco 2000 study to identify state development strategies	Completed

Source: FIDEJAL, 1994

Solicitations for FIDEJAL projects are published in the following national and regional newspapers: *El Financiero*, *Excelsior*, *El Norte*, *El Informador*, *El Occidental* and *Siglo 21*.

Proposals are usually due 45 days from the date the solicitation is published. Firms bidding on FIDEJAL procurements should be registered with SEDESOL.

North American Environmental Fund (NAEF). The NAEF is a $50 million fund organized in 1992 to make equity investments in public and private companies in the environmental sector in both Mexico and the United States. According to the fund's managers, the focus of these investments will be the commercialization of environmental technology and products for both industrial and urban applications. The fund will focus on established environmental companies, but it will also make investments in strategic funds that are active in the environmental sector. NAEF's minimum investment is $500,000 and the maximum is $5 million. The fund's major partners are NAFINSA (25%) and Japan's Overseas Economic Cooperation Fund (OECF) (25%).

Minor partners include WMX Technologies (U.S.), PEMEX (Mexico), Grupo ICA (Mexico), Hassa (Spain), Ebara Corporation (Japan) and Fidelitas (Belgium).

The fund is managed by the Ventana Group of Irvine, California, and is being jointly organized by Ventana and NAFINSA. Ventana has over 10 years of experience making equity investments in environmental projects, and currently manages a similar fund for *maquiladoras* (Mexico's in-bond assembly companies) that have an environmental component. NAFINSA will serve as strategic advisor to the fund and its portfolio companies, and will evaluate investment proposals.

The fund is also receiving assistance from the Fundación Empresarial para la Restauración Ambiental (Fundación Ambiental), a group of representatives from 15 of the largest Mexican industrial concerns, including NAFINSA, Volkswagen de México, Grupo Cifra, Cervecería Modelo, Grupo Condumex, Grupo Cydsa, Industrias Resistol and Grupo Desc. Fundación Ambiental will assist in attracting capital and participate in the fund's Business Advisory Council. To date, the fund has emphasized investments in U.S. environmental firms entering the Mexican market such as Safety Storage, Inc. and others.

Ventana expects to attract $300 million in co-investment private equity capital and up to $1 billion in total project financing, if the Mexican market demands it. This should translate into around 15 projects over a 10-year period. To date, the fund has done a relatively small volume of business; its managing director asserts that this is due, in part, to the economic slowdown, insufficient enforcement of environmental regulations, and the fact that several major solid waste concessions have not been awarded as expected. Nonetheless, there will be a slow improvement in these factors and the fund's volume of activity should increase over the next two to three years (Exhibit 9-9).

Exhibit 9-9
North American Environmental Fund (NAEF) Investments in Mexico

NAEF Equity Stakes in 1994	Potential NAEF Projects in 1994-1995
• $ 5 million in FYPASA's "Ecosys" projects, consisting of the design, construction and operation of two municipal wastewater treatment plants in Toluca-Lerma (requiring $40 million in financing) and a third in Leon • operating contracts for water treatment plants in Aguascalientes, Queretaro, Jalapa, Durango and Cautla • 25% stake in the Grupo Mexicana de Desarrollo joint venture for water supply and distribution in Puebla and Cancun • 49% of an operation to install recycling centers in the Grupo Cifra Supermarkets (a refurbished Celanese plastics plant will do the actual recycling)	• emissions testing laboratories • integrated energy savings consulting businesses • alternative fuels for fixed and mobile sources (LPG, natural gas, ethanol from sugar) with PEMEX as the partner • solvent recycling • solid waste disposal facilities • industrial wastewater treatment technologies • potable water facilities • tire recycling

APPENDIX A
ADDITIONAL TECHNICAL MATERIAL AND ORGANIZATIONAL CHARTS

Exhibit A-1: NAFTA Duty Reductions on Selected Categories of Pollution Control Equipment

Tariff rates for selected air pollution control equipment:

Product	Mexican Harmonized System Code	pre-NAFTA	1994
Dust collectors	8479.89.17	20%	18%
Catalytic converters	8479.89.14	20	18
Gas analyzers	9027.10.01	10	duty-free
Gas emissions testing equipment	9026.80.01	15	duty-free
Air filters	8421.39.05	15	duty-free
Monitory emissions equip.	9026.90.99	10	duty-free
Gas emissions meters	9028.10.01	10	8

Tariff rates for selected solid/hazardous waste disposal products:

Product	Mexican Harmonized System Code	pre-NAFTA	1994
Stabilizers	3812.30.99	15%	duty-free
Containers	7309.00.99	15	13.5
Special garbage crushing machines	8479.82.03	20	duty-free
Tank cars	8606.10.01	10	duty-free
Ionizing radiation detectors	9030.10.01	10	duty-free
Recycling equipment	8474.20.99	15	duty-free

Tariff rates for selected water pollution equipment products:

Product	Mexican Harmonized System Code	pre-NAFTA	1994
Flow Meters	9026.10.03	15%	12%
Barometers	9025.20.01	10	duty-free
Control valves	8481.80.11	15	13.5
Purifiers and deaerators	8421.29.01	15	12
Chlorinators	8241.21.02	10	8
Centrifuges to concentrate separate and clarify	8421.19.02	15	duty-free
Rotary pumps	8414.80.04	20	duty-free

Source: U.S. Department of Commerce, 1994.

Exhibit A-2
Proposed Reform of the Energy and Environment Secretariats

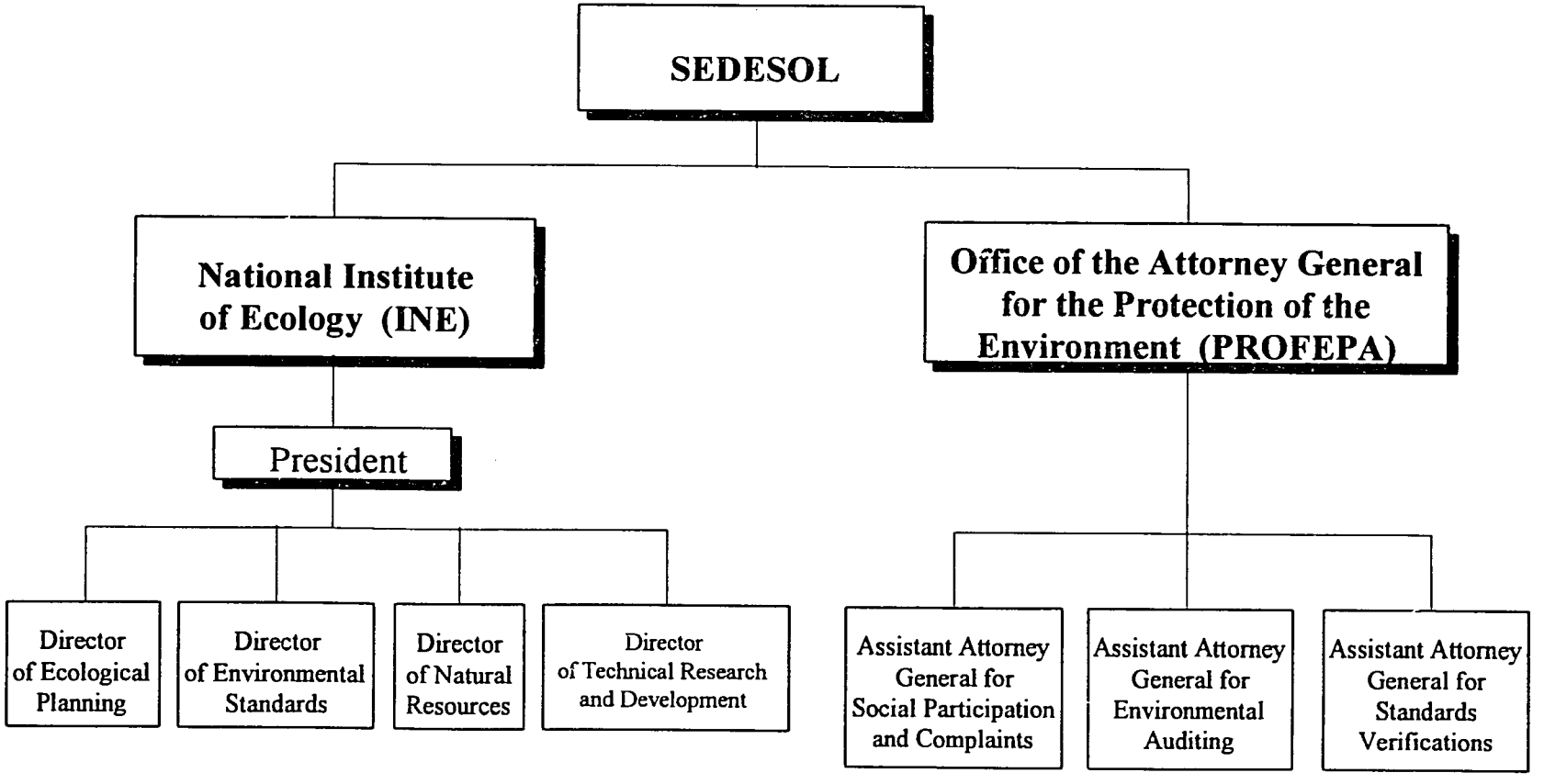
In December 1994, President Zedillo announced the restructuring of various secretariats with energy and environmental responsibilities. The primary secretariats that are affected by these changes are the Secretariat for Social Development (SEDESOL), the Secretariat for Agriculture and Water Resources (SARH), the Secretariat for Energy, Mines, and Parastatal Enterprises (SEMIP), and the Secretariat of Fisheries (SEPESCA).

Secretariat of the Environment, Natural Resources, and Fisheries. Under the new plan, the Secretariat of the Environment, Natural Resources, and Fisheries will be created and take over the environmental work of agencies that previously had environmental functions (SEDESOL, SARH, SEPESCA). This change is a move to provide better coordination of environmental protection measures. SEDESOL will continue to maintain its social development functions, but its environmental responsibilities will fall under a new secretariat. The new responsibilities of this agency will include:

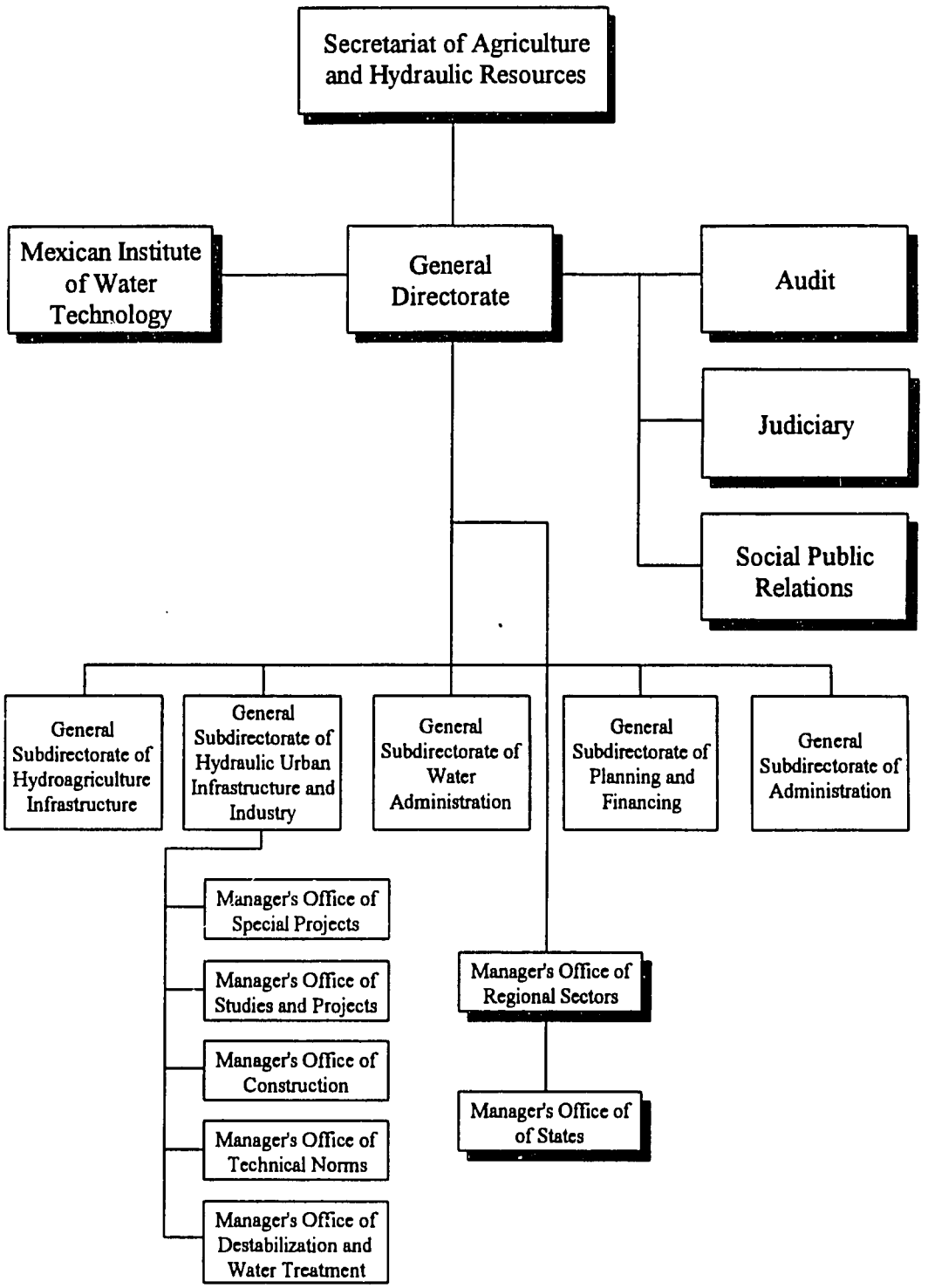
- **Environmental Policy Subsecretariat.** The National Institute of Ecology (INE), the decentralized agency within SEDESOL, will be converted into a subsecretariat within the Secretariat, but will maintain the same functions.
- **Attorney General for Protection of the Environment (PROFEPA)**. PROFEPA will remain an autonomous organism, but will fall under the new secretariat's domain.
- **National Water Commission (CNA).** CNA was formerly under the jurisdiction of SARH, but will become a decentralized organism under the new secretariat.
- **Natural Resources Subsecretariat**. The responsibility for managing all of Mexico's natural resources except for hydrocarbons will fall to this subsecretariat.
- **Fisheries Subsecretariat**. The responsibilities of SEPESCA will fall under the new secretariat.
- **General Direction of Forest Activities.** Responsibility for forest resources previously fell under the Forestry Subsecretariat of SARH.
- **General Direction of Mines Activities.** The mining activities under SEMIP will be moved to the new secretariat.

Secretary of Energy. The non-energy related activities of SEMIP will be removed from this secretariat and it will be renamed to reflect its new focus. Mining activities will now be housed under the Environmental Secretariat and parastatal management (what is left of it) will go to the Secretariat of Commerce and Industrial Development (SECOFI).

Organizational Chart
Secretariat of Social Development (SEDESOL)



Organizational Chart of the National Water Commission (Comisión Nacional del Agua (CNA)



Source: CNA, 1993.

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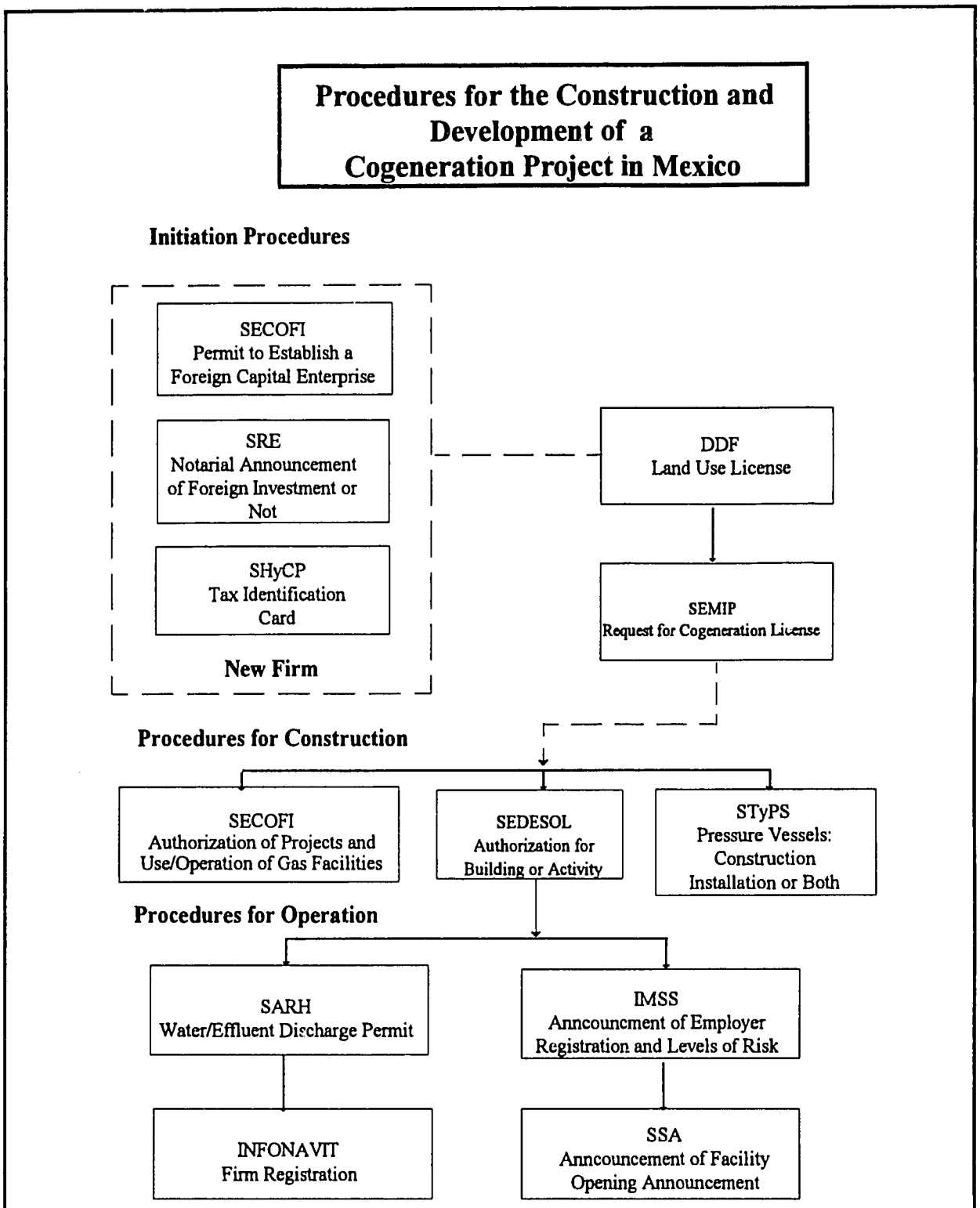
Estimated Annual Energy Savings by Sector
GWh)

Sector or End Use	*1998*	*2003*
Residential Refrigerators	660	1,900
Residential Air Conditioning	240	560
Other Residential Exept Lighting	270	470
Industry	990	3,340
Commercial	320	650
Residential Lighting	400	900
Public Lighting	140	330
Irrigation Pumping	230	430
Federal Government	90	160
Cogeneration	300	830
TOTAL	3,640	9,570

Source: CFE.



Source: Jorge Landa/USAID. November 1993.

Potential Cogeneration Projects to be Developed in Mexico

Plant	Installed Capacity (MW)	Initial Investment (US$ million)	Simple Payback Period (Years)	Internal Rate of Return	Present Value (US $ millions)	Cost of Generation (USc/kWh)	Prevailing Tariff (USc/kWh)	Incremental Energy Efficiency (kJ/kWh)
			Results of Financial Analysis					
Alvaro Obregon 1	50	58.3	7.9	10.5	-4.54	4.94	4.9	20,315
Alvaro Obregon 2	32	46.2	14.5	2.6	-11.12	5.54	4.9	24,871
Azufrera Pan. 1	15.8	2.2	2.2	-84.9	-4.41	3.83	4.2	n/c
Azufrera Pan. 2	22.7	10.7	6.0	-15.3	-4.45	3.73	4.2	n/c
Azufrera Pan. 3	23	2.1	n/c	116.4	29.6	1.55	4.2	n/c
Cydsa 1	296	192	4.6	24.6	54.3	3.22	4.8	6,206
Cydsa 2	116.5	77	3.0	59.6	55.6	2.60	4.8	4,658
Fibras Quimicas 1	161.6	130	7.9	16.9	8.8	3.58	3.8	7,854
Fibras Quimicas 2	62	62	5.6	18.8	4.1	3.89	3.8	5,568
Fibras Quimicas 3	28.7	28	3.6	30.8	7.4	3.79	3.8	4,950
Hylsa Puebla 1	33	21	8.7	3.2	-5.54	22.10	4.2	10,405
Hylsa Puebla 2	160	124	6.7	17.5	5.63	3.61	4.2	8,036
Sosa Texcoco 1	19.2	47	> 25	n/c	n/c	n/c	4.1	10,105
Sosa Texcoco 2	118.5	106	8.4	17.6	5.0	3.64	4.1	6,543

Source: CONAE/Cordinación de Cogeneración.

APPENDIX B
PROFILE OF ENVIRONMENTAL AND ENERGY MARKETS IN THE U.S.-MEXICO BORDER REGION

The border region between the United States and Mexico is approximately 2,000 miles in length. It stretches from the Pacific Ocean represented by the Ciudad Tijuana\San Diego area to the Gulf of Mexico represented by the Matamoros\Brownsville area. It is 80 kilometers deep on either side of the official international boundary. This region is dynamic both in terms of economics and environment. In the last twenty-five years, the border region has seen population increases averaging between 2-4% per year. Industrial development, located mainly in seven population centers, has increased over 150% in the last fourteen years.

The physical environment is made up of vast stretches of ecologically sensitive, arid landscape dotted by concentrations of population centered around scarce water resources. Fertile agricultural regions are located at both ends of the border in California and Texas, and there is irrigation-sustained agriculture along various points of the border. The main sources of water for agriculture, population and industry are the Tijuana River\Rio Tijuana, the New River (both in California), the Colorado River, the Rio Grande\Rio Bravo (completely along the Texas border), and various underground aquifers dotting the border.

Water is the most important factor for this region. It is, however, a limited resource. In this regard, the border region is directly affected by the water demands of the overall southwest region of the United States and the water demands of the northern region of Mexico. Scarce water resources, heavily depended upon by the border region, are therefore tied up in the increasing needs of the two countries. How this resource is managed in the border region will have a direct effect on the economic development of the region and on that development's environmental consequences.

The rapid population and industrial growth in the border region have not only affected the water resources of the region, but have spawned other environmental problems. Rapid growth has overshot the original infrastructure that had been in place to serve a much smaller population. The results have been uncontrolled and untreated wastewater discharges, unsound disposal of municipal and industrial waste, and escalating air pollution. Rapid growth has also increased demand for energy, and this, in turn, has added to the environmental problems of the region.

B.1 MAJOR POLLUTION PROBLEMS ALONG THE BORDER RANKED BY SEVERITY

- shortage of clean water for drinking and potability
- lack of proper disposal facilities for wastewater leading to contamination of water sources, food sources and natural habitat
- lack of disposal facilities for municipal waste
- need for increased generation of energy
- need to reduce air contaminants from vehicles and industry
- need to develop an infrastructure for reducing, recycling, transporting and disposing of hazardous waste

These are the major pollution problems along the border. Their recognition as such and their ranking are based on data gathered and analyzed by several independent public and private organizations. These agencies include the:

- The World Bank
- Center for Disease Control
- Council of the Americas
- U.S. Environmental Protection Agency
- Secretaria de Desarrollo Social
- Governor of the State of Texas, Task Force
- International Boundary and Water Commission.

It is also this ranking which is determining how funds allocated through The World Bank, the Inter-American Bank, and the North American Development Bank will be designated from now until the year 2003. This allocation of funds is discussed later in this section.

There are two factors which are propelling these problems:

- rapid population growth
- rapid industrial/economic growth

Each factor is shown in more detail in Exhibits B-1 and B-2.

Exhibit B-1
Population Statistics: U.S.-Mexico Border

Metropolitan Area***	1990 Statistics	1980-90 Compounded Annual Growth Rate	Projected Pop. by 2003
Tijuana	747,381	4.94%	1,399,654
San Diego	2,498,016	2.98%	3,660,511
Mexicali	601,938	1.67%	746,129
Calexico*	109,303	2.60%	152,636
Nogales (MX)	107,119	4.64%	193,106
Nogales (US)	29,676	2.20%	39,371
Ciudad Juarez	797,679	3.47	1,242,171
El Paso	591,610	2.11%	776,574
Nuevo Laredo	219,468	.77%	242,445
Laredo	133,239	2.99%	195,300
Reynosa	282,667	2.48%	388,500
McAllen	383,545	3.08%	568,848
Matamoros	303,392	2.42%	414,063
Brownsville	260,120	2.18%	344,151
Totals	**7,065,153**		**10,363,461**
Averages**	**504,654**	**2.94**	**740,247**

Source: Centro Nacional de Desarrollo Municipal (for MX data)
Integrated Environmental Border Plan -- EPA -- (for U.S. data)

*Growth rates used are city growth rates because country growth rates were not available
** Average annual growth rate is a weighted average.
***U.S. population is for country in which the named city is located.

Exhibit B-2
Maquiladora Growth Rate Along the Border

Border Cities (within 100 km.)	Number of Maquiladoras			Number of Employees
	89	90	91	
Tijuana	334	530	656	70,262
Ciudad Juarez	260	309	321	134,838
Mexicali	131	148	122	19,400
Matamoros	72	89	94	38,268
Tecate	46	86	110	5,934
Nuevo Laredo	63	67	93	21,000
Nogales	64	65	75	21,084
Reynosa	35	57	82	30,000
Piedras Negras	30	39	37	7,182
Ciudad Acuna	32	36	46	14,261
Ensenada	--	33	44	5,706
Agua Prieta	28	28	27	7,500
San Luis Rio Colorado	0	12	23	3,000
Naco	0	0	4	1,200
Palomas	0	0	5	13
Total	**1,100**	**1,499**	**1,739**	**379,772**

Source: U.S. EPA, Integrated Environmental Plan, Aug. 1991

- In 1990, there were 620 *maquiladoras* nationally, employing 119,500 workers.[1]
- In 1990, there were 1,707 *maquiladoras* nationally, employing 448,000 workers.[2]
- It is estimated that an additional 200,000 jobs are indirectly created in Mexico (mainly along the border) by the *maquiladora* industry.
- It is estimated that an additional 125,000 jobs on the U.S. side of the border are a direct result of the *maquiladoras* on the Mexico side of the border.

[1] U.S. Council of the Americas, Analysis of Environmental Infrastructure Requirements and Financing Gaps on the U.S./Mexico Border, July 1993, p.10.

[2] Ibid, p. 10.

The *maquiladoras*[3] represent a major employment sector along the border and as such are a good indicator of economic and employment growth along the Mexican side of the border. Approximately 50% of the *maquiladoras* have some level of U.S. ownership and one-third of these are completely U.S. owned.[4]

- Average manufacturing wages in Mexico are $8,500 per year.[5]
- The average loaded hour (wage, benefits, holiday time, etc) per *maquiladora* worker is between $3.50 and $5.00.
- *Maquiladora* wages have raised the average income along the border to between $2,500 and $3,700.[6]

The growth of the *maquiladoras* increased dramatically after the devaluation of the peso in 1982 and again in 1988. The effect of both devaluations was to make labor in Mexico extremely cheap and very attractive to companies which had labor-intensive assembly work. This economic growth was mirrored on the U.S. side of the border where jobs were created to directly and indirectly service the needs of the growing maquiladora industry (see Exhibit B-3 for a comparison of employment in key sectors along the U.S. side of the border).

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[3] *Maquiladoras* are in-bond facilities that were originally created by the Mexican Government in 1965. They are factories that are allowed to import components into Mexico without tariffs for assembly and must return the worked product to the country of origin, where they pay a nominal tariff on the "value added" to the product. The reason behind their creation was to bring employment to the north of Mexico.

[4] See U.S. Council of the Americas, *Analysis*, p. 4.

[5] Neal Templin, *The Wall Street Journal*, June 29, 1994, p. A1.

[6] See U.S. Council of the Americas, *Analysis*, p. 10.

Exhibit B-3
Business Employment Patterns for U.S. Border Counties
(Number of Employees by Industry)

State*	Agriculture Forestry and Fishing	Construc-tion	Manufac-turing	Trans-port and Public Utilities	Wholesale Trade	Retail Trade	Finance Insurance Real Estate	Services
AZ								
1970	734	9,658	10,403	5,714	5,757	28,365	6,201	24,925
1980	2,047	19,993	24,839	10,319	10,340	47,520	11,654	46,125
1991	3,306	17,132	31,339	12,074	13,166	72,073	13,640	94,050
CA								
1970	2,685	20,548	74,590	20,220	15,193	78,667	20,244	68,390
1980	5,036	38,904	29,849	30,002	133,900	45,076	152,529	5,477
1991	10,207	51,710	133,427	36,071	45,199	201,724	73,187	300,461
NM								
1970	179	942	1,676	1,235	396	4,375	824	2,662
1980	307	2,256	2,013	1,152	949	6,231	1,250	4,168
1991	449	2,387	3,583	1,562	1,380	10,835	2,234	9,106
TX								
1970	1,881	10,970	32,471	12,275	16,585	44,189	8,687	28,250
1980	1,535	22,102	58,475	18,573	26,066	76,182	14,243	48,078
1991	2,373	16,465	59,215	23,440	25,766	107,142	18,212	98,859

Source: *County Business Patterns*, U.S. Department of Commerce, Bureau of the Census.

Water and Wastewater

The population and economic growth rates noted above have resulted in increasing demands for potable water on both sides of the border.

- Potable water requirements on the U.S. side of the border are estimated to increase by 24.1% over the next ten years.[7]

- The *colonias* (unincorporated neighborhoods outside the municipal boundaries of many cities along the border), totaling over 250,000 residences along the U.S.

[7] Council of the Americas, *Analysis*, p.12.

border, lack access to water or wastewater services. 23% in Texas and 20% in New Mexico have no adequate water supplies.[8]

- In the Upper Rio Grande Basin near the Texas-New Mexico border, agriculture uses 70% of the water supply. However, by the year 2010, municipal water users in El Paso county are expected to be the major water users, with 53% of the total.[9]

- El Paso currently obtains 75% of its drinking water from groundwater. El Paso and Juarez pump 325,000 acre feet per year out of the Hueco Bolson Aquifer, while the recharge rate is only 25,000 acre-feet per year.

- The National Water Commission of Mexico (CNA) estimates that 80% of the residents along the border have access to running, potable water on their property sites. However, "potable" means treated to a level usable for most household purposes but not for drinking. Most residents who can afford to, buy bottled water at an average cost of $2 for five gallon bottles.[10]

- 20% of the Mexican border population is without access to running water.[11]

No exact figures exist on the amount of wastewater generated by communities and industry on the Mexico side of the border.[12] However, the problems are well documented and the following points will help to put the magnitude of the problem in perspective.

- In many communities along the Mexican side of the border there is no collection or treatment of either municipal or industrial wastewater.

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[8] Ibid, p. 12.

[9] Jan Gilbreath Rich, *Planning the Border's Future: The Mexican-U.S. Integrated Border Environmental Plan,* March 1992, p.13.

[10] Comision National de Agua, 1993.

[11] National Center for Municipal Development of Mexico, 1993 census data.

[12] The National Commission of Municipal Development (CNMD) estimates that within the seven principal Mexican border cities, a weighted average of 13.23% of total sewage flows were collected. The CNMD also estimates the total of flow at 60 gallons per day per capita. See U.S. Council of the Americas, *Analysis,* p. 17.

- Ciudad Juárez, the largest Mexican city on the border with 1.2 million residents, has only rudimentary wastewater treatment handling and no primary treatment of household sewage.[13]

- Nuevo Laredo dumps approximately 27 million gallons of raw sewage each day into the Rio Grande/Rio Bravo.[14]

- To stop sewage discharge into the Nogales Wash, the IBWC is in the processes of expanding the sewage treatment plant for the two Nogales from 8.2 million gallons per day to 17.2 million gallons per day.[15]

- Yet surface water and shallow drinking water wells have been contaminated with pathogenic microorganisms.

- Only 1% of the *colonias* on the Texas border are served by sewer hook-ups.

- In the state of New Mexico approximately 7% of the *colonias* population have sewer hook-ups.

- Due to constant dumping of municipal and industrial wastewater into the Tijuana river in Mexico, a 2.5 mile stretch of beach north of the border has been under public health quarantine since 1980.

- Much of the wastewater generated by the communities on the Mexican side of the border is dumped into the Rio Grande/Rio Bravo -- the main source of drinking water for most of the Texas-Mexico border area.

Due to the importance and scarcity of potable water along much of the U.S.-Mexico border, priority has been given to securing potable water for both sides of the border, and to cleaning up the wastewater generated by both countries along the border.

With the exception of one plant operated by the City of Brownsville, all plants on the U.S. side of the border discharge into interior drainage systems away from the main rivers and tributaries along the border. The plant in Brownsville discharges secondary treated and disinfected effluent into the Rio Grande.

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[13] Jan Gilbreath Rich, *Planning the Border's Future*, p. 12.

[14] Ibid., p. 12.

[15] Ibid, p. 11.

Exhibit B-4 gives cost and time estimates for the building of necessary treatment and collection systems along the border. Due to the disparity between the two countries' systems, two-thirds of the allocation is on the Mexican side. It should also be noted that some facilities, such as the one slated for San Diego, will actually be treating wastewater from both sides of the border.

Exhibit B-4
Wastewater Collection and Treatment (1993-2003)

	Cost (in mil)	Timeframe
MEXICO		
Tijuana	$ 324*	1994 - 2010
Nogales	115**	1993 - 1995
Mexicali	447**	1993 - 1997
Juarez	850**	1994 - 1998
Reynosa	285**	1993 - 2003
Matamoros	294**	1996 - 1999
Tecate	227**	1993 - 2008
Others (5)	262**	1993 - 2005
Subtotal:	$2,804.	
UNITED STATES		
San Diego	$ 244***	1993 - 2003
Calexico	72***	1993 - 2003
Nogales	17***	1993 - 2003
TX Municipal	592****	1993 - 2003
Colonias	550*****	1993 - 2003
Subtotal:	$1,475.	
TOTAL	**$4,279.**	

* Cost of international wastewater treatment plan as estimated by the San Diego Clean Water Program. 1993.

** IBWC Sanitation Issues, prepared for U.S. Section-IBWC by U.S. Army Corps of Engineers, Sept. 1992.

*** *Southwest Border Infrastructure* Initiative, Border Trade Alliance, Final Report, Feb. 1993.

**** Texas Water Development Board, 1992.

***** Texas Water Development Board and Environmental Protection Agency, 1992.

Source: U.S. Council of the Americas

Municipal and Industrial Waste

Another major problem - and one which has been targeted for immediate attention - is the municipal waste issue. The problem is almost entirely on the Mexican side of the border. There are several reasons for this:

- Mexico has had no user fee structure in place for garbage collection and disposal. Municipalities collect the garbage for free.
- The garbage that is collected is usually dumped in unlined, uncovered, landfills.
- Mexicans generate only 1.4 lb. of solid waste per day (as opposed to 4.3 per day in the United States,[16] but only 46% to 76% is actually collected.
- Waste for the Mexican border region is projected to increase from 868,000 tons in 1992 to 1.27 million tons in 2003 (see Exhibit B-5).

Exhibit B-5
Mexico Landfill* Tonnage and Cost Estimates (1993-2003)

Metropolitan Area	2003 Estimate of Total Waste Generated per City (metric tons)**	Total Landfill Costs: Construction Only***
Tijuana	332,068	$ 94,971,454
Mexicali	136,169	38,944,222
Nogales (MX)	63,435	18,142,542
Ciudad Juarez	294,705	84,285,646
Nuevo Laredo	57,520	16,450,759
Reynosa	92,172	26,361,071
Matamoros	151,133	43,224,073
Totals	**1,127,202**	**$322,379,767**

* Excludes commercial and industrial solid waste.
** Total municipal solid waste generated in 2003 based on .65 kg per capita per day x 365
*** Based on U.S. landfill construction cost estimates of $13.00/U.S. ton of waste, usable life of 20 yrs.

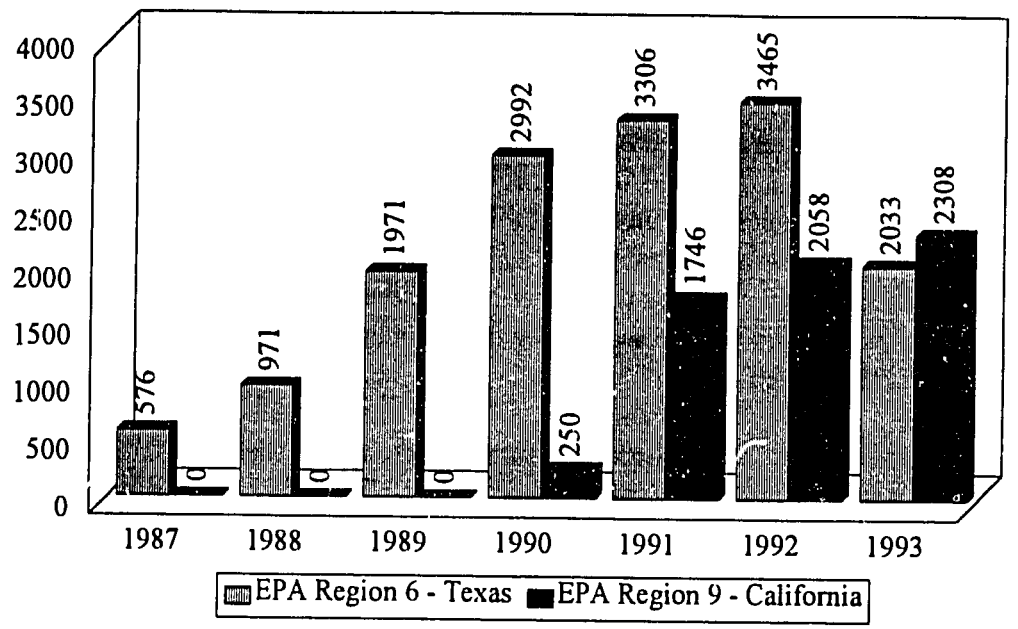
Sources: 1. Cost Estimates: Office of the Governor of Texas
2. Population Estimate: CNDM 3. Waste Generation Estimate: SEDESOL

[16] *U.S. - Mexico Integrated Border Environmental Plan*, 1992.

The $322+ million investment is to construct sanitary landfills for 100% of the waste stream. This assumes a 20-year capacity and a waste stream cost of $13 per ton for a basic clay liner-type landfill.[17]

The hazardous industrial waste situation is much more amorphous. Under the La Paz Agreement of 1983, all waste generated in the *maquiladoras* that is the result of imported components and chemicals must be returned to the country of origin. Due to stepped up enforcement by SEDUE (and now SEDESOL) and the U.S. EPA, volumes of waste returned to the United States increased exponentially over a six year period (Exhibit B-6).

Exhibit B-6
Mexican Hazardous Waste Exports to the United States
(Tons of U.S. Hazardous Waste Received from Mexico)



However, these figures are in no way a true measure of the amounts of hazardous industrial waste generated along the U.S.-Mexican border. There are several mitigating factors that make it difficult to determine the extent of the problem.

[17] Council of the Americas, *Analysis*, p. 18.

- It is estimated that less than 50% of *maquiladoras* generating hazardous waste are in compliance with *even the paperwork requirements.*

- Large amounts of industrial waste are either dumped illegally or poured down the drain by both the *maquiladora* industry and by the Mexican-owned factories.[18]

- Mexican industry is required to fill out the same ecological waybills as the *maquiladoras* when transporting hazardous waste for recycling, treatment or final disposal. However, SEDESOL, which is responsible for this paperwork, has not published these numbers. There is no open records act in Mexico.

Currently, Mexico has one major hazardous waste landfill that is permitted and approved for the disposal of hazardous waste. This facility is located outside of Monterrey. There are plans for another facility outside of San Luis Potesi and two more in the area of Guadalajara. These sites have been granted permits and are in various stages of development. It is the one close to Monterrey, however, that is close enough to service the border region.

Other facilities that can recycle, treat or dispose of industrial waste along the border are:

- Spent solvent recycling facility in Tijuana - Ensenada area
  Chemical Waste Management

- Spent solvent recycling facility in Chihuahua
  Quimica Fortek

- Lead recycling facility in Monterrey
  Acumuladores Mexicanos

- Lead recycling facility in Reynosa
  Metrometal

- Dust bag recycling facility in Monterrey
  Zinc Nacional

- Heavy metal extraction facility in Monterrey
  Chemical Waste Management

[18] From private interviews conducted with industry by Market Strategies International in 1993.

- Aluminum recycling facility in Tijuana
  Maquiladora Russment

- Non-hazardous industrial waste landfill in Matamoros
  FINSA

- Medical waste incineration facility outside of Matamoros
  FINSA.

In their analysis of border infrastructure needs in 1993, the U.S. Council of the Americas questioned whether there was enough hazardous industrial waste currently generated to cost effectively support any major hazardous waste disposal facilities along the border. Based on U.S. Trade & Development Agency figures, the Council estimated that the border region could possibly support three such facilities (projected plant cost of $250 million to build) over the next ten years.[19]

However, a cautionary note should be sounded. Mexican industry is showing the same market trends as U.S. industry in regard to pollution minimization and waste reduction at the plant site. If manufacturers continue in this trend, the market for off-site recycling, treatment and disposal in Mexico may become irrelevant before it is ever built.

Energy

The need for energy will be of critical importance to the border region over the next 15 years.

- Energy demand in the U.S.- Mexican border is expected to increase at a rate of 7-8% per year through 2009, requiring capacity to be more than double in the next 15 years.[20]

The border region has large reserves of natural gas and low-grade coal. It also has some hydroelectrical and thermoelectrical power. All of these resources, along with oil, are currently used in some amount to supply electrical power to the border. Exhibit B-7 shows the Mexican national utility's (CFE) installed capacity for the border region, and how that power is being generated.

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[19] See U.S. Council of the Americas, *Analysis*, p. 20.

[20] Alan Sweedler, "Energy and Environment in the U.S. - Mexico Border Region," Nov. 11-14, 1992, Merida, Mexico, conference.

Both natural gas and coal reserves are being looked at by the Mexican Government as ways to increase energy output for the growing economy in the northern part of the country. Additionally, state and municipal governments are interested in the idea of cogeneration, both to increase energy outputs and to dispose of municipal waste. Which sources of power are chosen and in what quantities, and which methods are chosen to use and distribute them will have a profound impact on the ecosystem of the border region.

Exhibit B-7
CFE System Installed Capacity (Megawatts)

Type	Name of Facility or Site Location	Capacity	Total
Hydro	Falcon	31.5	
	La Amistad	66.0	
	Sonora region**	419.0	
	Chihuahua region**	25.0	541.5
Fuel Oil/Gas	Monterrey	566.0	
	Rio Bravo	375.0	
	Rosarita	300.0	1,241.0
Coal	Carbon I	1,200.0	
	Carbon II	1,400.0	2,600.0
Gas Turbine	Monterrey	98.0	
	Monclova	78.0	
	Arroyo del Coyote	24.0	
	Baja California Region****	177.0	
	Sonora Region**	130.0	
	Chihuahua Region***	281.0	788.0
Geothermal	Cerro Prieto	620.0	3,541.0
	Sonora Region	1,867.0	
	Chihuahua Region***	1,054.0	
Combined Cycle	Huinala	377.5	
	Chihuahua Region	180.0	557.5

Source: U.S. Dept. of Energy & Secretaria de Energia, Minas e Industria Paraestatal, *United States/Mexico Electricity Trade Study*, March 1991.

The report was a combination of two separate reports prepared by different regional districts of both countries. The regional report for the Texas- Mexico Districts was more precise in naming exact facilities and capacities.

** Overall capacity in this category for the Sonora region. Serves the entire area, not just the border.
*** Overall capacity in this category for the Chihuahua region.
**** Combined capacity for plants at Mexicali, Tijuana, and Ensenada using gas turbines.

Air Quality

Air quality and the problem of air pollution are a major concern along the U.S. - Mexico border.

- El Paso has the worst air pollution in Texas and ranks in the ten worst cities in the United States.[21]

- The San Diego area has been classified by the State of California as having severe air quality problems. It is doubtful that the city will succeed in meeting the state standards before the year 2000.[22]

Until 1990, there was no monitoring of air quality along the Mexico side of the border. Currently, there are monitoring stations in Tijuana and Juarez. However, the Mexican cities along the border share air transfer routes with their sister cities on the U.S. side. The following border communities currently do not attain one or more U.S. National Ambient Air Quality Standards:

- San Diego (ozone, CO)
- Imperial Country (PM-10)
- El Paso County (ozone, CO, PM-10)
- Yuma, Pima Santa Cruz and Cochise counties (PM-10)
- Dona Ana County (PM-10)

B.2 ENVIRONMENTAL REGULATION

Border Enforcement Agencies and Structure

The environmental regulatory structure in Mexico is highly centralized. The federal agency which has jurisdiction over environmental matters is the Secretaria de Desarrollo Social or the Secretary of Social Development (SEDESOL). This jurisdiction, however, is shared in certain matters with the National Water Commission (CNA), the Secretary of Communications and Transportation (SCT), and the Ministry of Labor. The environmental regulatory framework is divided into three sections; the Law of Ecology, the seven regulations, and (to date) 84 technical standards or NOMs.

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[21] Environmental Defense Fund, *Solving Air Pollution Problems in the Paso Del Nort*, p. 1. June 7, 1994.

[22] See U.S. EPA, *Integrated Environmental Plan*, pp. 111-33.

Each of the 31 states and the Federal District is required to promulgate its own environmental laws and to set standards that are no less strict than the federal government's. There is also some environmental regulation on the municipal level, mainly dealing with water/wastewater and municipal solid waste. There has been pressure in recent years to decentralize the control of environmental matters. This pressure has been placed by local and state groups and by the international funding agencies (World Bank and Inter-American Bank) who feel that funding and enforcement can be better administered on local and state levels. However, Mexico does not yet have the funding mechanisms in place to allow such an evolution.

Over the past six years, environmental regulations at both the federal and state levels have become more clearly defined and have increased in stringency. Enforcement on both the federal and state levels has also increased markedly over this same time period. A dramatic increase in enforcement took place when the old SEDUE became SEDESOL in 1992. During the six months after the inception of the Attorney General's Office for the Protection of the Environment (PROFEPA), enforcement actions increased by 200%. Over the same time period, SEDESOL increased enforcement personnel and staff along the border from 19 to 200. The federal government stations inspectors from both the PROFEPA and the National Institute of Ecology (INE) in each state. The PROFEPA is responsible for compliance and enforcement matters, and the INE assists with permitting and technical questions.

Several state governments have followed suit. Many states with environmental laws in place have their own inspector corps, as well as their own procedures for permitting, reporting and tracking hazardous waste, wastewater discharge and air emissions. However, levels of regulatory stringency and enforcement vary dramatically from state to state. These contrasts are particularly evident along the U.S.-Mexico border.

Among the six Mexican states touching the border, the State of Neuvo Leon has the best state environmental structure in place, and has one of the highest enforcement records. This is followed closely by the State of Chihuahua. The State of Tamaulipas, while having environmental laws and standards, is considered to have the least-active state environmental agency and the lowest state enforcement record. Some of this has been offset by a more active federal PROFEPA.

Enforcement of state and federal regulations at both the state and municipal levels are affected by three factors:

- commitment at the state government level to environmental issues, spurred by public involvement and political considerations.
- availability of funds for enforcement and compliance procedures.

- working relationship between industry and the state government and between the state and federal government.

Additionally, regulatory levels vary between the seven major community groupings along the border.

Environmental regulatory issues on the U.S. side of the border are administered by Region VI (the Texas and New Mexico border) and Region IX (the Arizona and California border) of the EPA at the federal level. Several other federal agencies also have jurisdiction over different areas affecting the environment, mainly in the movement and transport of waste, but also concerning national parks along the border, and water shared by the two countries. Such agencies include Treasury, Department of Transportation, Drug Enforcement Agency, Nuclear Regulatory Agency, State Department, Department of the Interior and the Parks and Wildlife Service.

Additionally, each of the states along the border has various state agencies which enforce state environmental regulations. There is much overlap among programs for enforcement and compliance. However, the state and federal agencies seem to work fairly well together. In recent years, the U.S. EPA, the Treasury Department and the Texas Natural Resource Conservation Commission (TNRCC) in Texas and the California EPA (CalEPA) in California have coordinated border checks of hazardous materials and waste crossing to and from Mexico. These actions have resulted in criminal actions being brought against smugglers of hazardous waste into Mexico and illegal dumping by U.S. firms along the border.

Both federal and state agencies have also worked out voluntary environmental programs with their Mexican counterparts. These programs have ranged from joint inspections of plants on both sides of the border to training programs for new inspectors. U.S. EPA and SEDESOL also share information on hazardous material and waste transborder shipments.

However, it should be recognized that enforcement of environmental regulations is a strictly national issue. There are no bilateral regulatory and enforcement mechanisms. There are agreements between Mexico and the United States, the most notable being the La Paz Agreement of 1983 (which sets out the requirement that *maquiladoras* return their waste to the country of origin). There are also various treaties in place governing the sharing of water resources along the border. These international agreements and treaties, however, do not create an enforcement structure. Nor does the new North American Free Trade Agreement (NAFTA).

Trends in State and Municipal Environmental Regulations Along the Border

Despite this inconsistency, certain trends can be seen.

- Enforcement has consistently increased along the border.
- Regulations have been more consistently enforced on *maquiladoras* than on Mexican-owned facilities.[23]
- The category seeing the highest level of regulatory action along the border has been wastewater discharge, followed by non-compliance on paperwork or procedures in handling, storing and transporting hazardous industrial waste. Air emissions standards have seen the least enforcement.[24]

Industries Affected by Enforcement

Along the border, the *maquiladoras* have taken the brunt of the enforcement action. This is not unusual. The *maquiladoras* make up the majority of industry along the border, and, therefore, would be more susceptible to the enforcement of environmental regulations. Enforcement in the region was substantially increased after the creation of SEDESOL in May 1992.[25]

- From May 1992 to October 1993, more than 2,440 border region industrial facilities were inspected.
- Citations were issued to 942 industries for failure to comply fully with the law.
- Temporary or partial shutdowns during that time numbered 202 facilities.
- Permanent closures numbered 58 facilities.
- Fines or other enforcement measures were levied against 799 facilities.

[23] Note that this may be due more to the nature of the industry than actual ownership characteristics. Most Mexican industry is much smaller and less able to afford the burden of regulation. Also, while foreign-owned facilities may turn out less pollution percentage wise, they account for larger quantities. Finally, in the State of Nuevo Leon, where Mexican-owned facilities compete with foreign-owned ones on scale of size and resources, the Mexican-owned facilities have been heavily hit by state and federal inspectors for non-compliance.

[24] Again, the exception has been around Monterrey in Nuevo Leon, where there has been heavy emphasis on compliance by industry with air emission standards.

[25] SEDESOL government statistics, April 1993.

No one industry sector has been singled out. Rather, enforcement has emphasized certain types of violations over others. There has been more enforcement against wastewater discharge violations than air emissions violations. There has also been heavy emphasis on paperwork compliance. The SEDESOL inspectors have also seemed to be relatively unaware of whether *maquiladoras* or other facilities are large or small when applying the regulations.

- EPA estimates that in 1993, 351 EPA inspections and 1,671 state inspections were executed along the U.S. side of the border.[26]
- There were 15 civil judicial enforcement actions.
- There were 114 administrative actions.
- There were 3 EPA-led criminal prosecutions.

B.3 ALLOCATION OF FUNDS FOR THE ENVIRONMENT

As stated earlier, the most immediates need along the border are for the delivery of potable water and for the proper treatment and disposal of wastewater. It is this area of infrastructure that the public funding sources will stress. The second area of funding will fall on municipal waste disposal.

There are several public entities funding the border region. They include The World Bank (see Exhibit B-8 for funding allocations by The World Bank to the border region), the InterAmerican Development Bank, and the newly formed North American Development Bank. Both the U.S. and Mexican Governments will provide additional funding through various international (the International Boundary and Water Commission - IBWC) and federal agencies and many of the states touching the border will provide funding for projects within their own states.

- Funding from The World Bank to the border region by 1996 will total $550 million.
- The NADBank is ultimately expected to reach $2 to $3 billion by 1997 for infrastructure projects along the border (this money covers environmental and other infrastructure needs).

[26] U.S. EPA, *Progress Report on U.S. - Mexico Activities as Outlined in the Integrated Border Environmental Plan*, October 1993, pp. 3-4.

- The Inter-American Development Bank is extending loans for specific projects, such as the Tijuana/San Diego Wastewater Project ($200 million), along the border.

Exhibit B-8
Proposed World Bank Loans to Mexico for Environment
Fiscal Years 1993 - 1994, (millions of U.S. dollars)

Loan	1993	1994	1995	1996
Air Quality	220			
Border Area I**		250*		
Water/Sanitation II			300	
Solid Waste II			250	
Toxic Waste			200	
Border Areas II***				300
Industrial Pollution				300

Source: World Bank, *Country Strategy Report*: Mexico, June 14, 1993.

* Other information from the Bank lists this loan as $350 million.
** Majority of loan for environmental planning at federal, state and municipal levels; development of protected area management plans; industrial and hazardous waste management strategy; water, wastewater and solid waste infrastructure construction and urban transport.
*** Type of environmental assessment requirement to be determined. Similar to Northern Border I.

- Clean Water State Revolving Funds (SRFs) among the U.S. border states have a balance of over $1 billion available.

- Separate funding through the U.S. EPA, the IBWC, SEDESOL and various state agencies along the border is being used to finance research and specific water/wastewater projects.

Funding through government agencies is subject to the budgeting process of both federal governments. Presently, neither Mexico nor the United States has made a full allocation of funds

to the NADBank for FYI 1995. Each country has cut their promised $335 million in half. The funding process in both countries will also affect separate allocations to the environmental agencies that monitor and regulate the border region. This means that funding for the Integrated Border Plan, administered by the EPA and SEDESOL, for 1995 is not yet clear.

Two areas of funding that are also affected by U.S. budgetary considerations are the International Boundary and Water Commission and the State Revolving Funds. The IBWC has oversight for the various water treaties between the United States and Mexico. It does not have regulatory capacity. However, it does issue requests for proposals for projects along the border (the international wastewater treatment project in Nogales is an example of an IBWC project) and has its own funds for these projects.

The SRFs are funded by the U.S. Government under the Clean Water Act. These funds are available to every state for use on projects identified by the states. In the case of the border states, much of this money is being used for projects along the border. The SRFs are not grants, but loans. Communities compete for these loans on basis of need and on the ability to repay the loans. It is this qualification which has put much of the funding out of reach of the *colonias* -- they simply do not have the tax base to repay the loans.

Several of the states have attempted to solve the *colonias'* problem by issuing taxpayer-voted bonds for both water and wastewater projects. These allocations are specifically for the *colonias*. Finally, the U.S. Congress also appropriated funding for the Farmers Home Administration to address the environmental needs of the *colonias* along the border. None of this money is available for projects outside the designated state.

B.4 SECTORIAL MARKET ASSESSMENTS

The rapid economic growth and its accompanying environmental problems along the U.S.-Mexican border offer major opportunities for U.S. firms in the environmental and energy industries. These opportunities are in both the public and private sector and often entail providing a combination of equipment sales coupled with technical services. There is much need for traditional projects and products (wastewater treatment facilities, pollution abatement equipment, etc.) and for innovative ones (subsurface drip irrigation disposal of wastewater, composting of municipal waste for methane generated energy, etc.). However, while the opportunities are endless, the money is not. Companies competing for the larger projects will be asked to bring financing to such projects and to consider more "build, operate, and transfer" (BOT or BLeaseT in the case of water and electricity) relationships.

Additionally, U.S. firms in both the equipment manufacturing and services sectors face growing competition from European, Canadian and Japanese, as well as newly created Mexican competitors. On larger projects, such as the construction of traditional wastewater treatment facilities, power plant facilities, and waste to energy facilities, U.S. companies can expect to face foreign competitors who have access to government financing and subsidizing.

In the border region, however, U.S. firms in the environmental business, either on their own or in joint-ventures with Mexican counterparts, control 90% of the market. There are several reasons for this:

- proximity to and familiarity with the United States
- preference for U.S. goods and services
- aggressive nature of U.S. companies in entering this region (especially Texas and California firms)
- U.S. ownership of main sector of industry (*maquiladoras*) and consequent sourcing policies
- ability of U.S. firms to access financing

With the NAFTA in place, U.S. environmental equipment will have additional cost advantages through a lowering of tariffs on environmental equipment. Prior to NAFTA, environmental equipment carried an 18% tariff. This will be phased out to 0% by 1998.

The largest growth potential in the environmental area for the border region is in water/wastewater, municipal waste, and environmental services.

Energy-Related Environmental Equipment and Services Market

Regulatory developments

- Increased stringency in air emission regulations will make the use of low-grade coal for fueling power plants more costly (and controversial).
- Increased enforcement of regulations requiring annual filing of air emissions inventory will drive power plants and manufacturers to consider energy audits and emissions abatement equipment.

Current investment. There is no way to directly access how much money is being spent on energy-related environmental services or equipment in the border region. However, key factors point to particular areas for investment, especially in the public sector. Most of the money for financing these public sector projects comes from the Mexican Government and its expenditures for the CFE, and through the environmental infrastructure projects being funded by The World Bank and the NADBank. Additional funding can come from the private arm of The Work Bank, the International Finance Corp.

- government expenditures are used in retrofitting older facilities (estimated to be between $200 to $500 million per plant)
- government installation of monitoring equipment at CFE facilities
- potential funds for waste to energy projects could come out of the money marked for municipal waste disposal on the Mexican side of the border.

Private sector projects favor environmental services and air emissions equipment. Energy audits normally average between $20,000 to $50,000 per facility, depending on the location of the facility, its size, and the hourly rate of the engineering firm.

Market estimates and projections. It is difficult to determine market size energy related environmental products and services in the border region. First, there are no separate figures for imports into Mexico by region. Secondly, it is difficult to break environmental products and services for the energy sector out of the overall products picture for either the energy sector or the environmental sector.

While energy consumption is expected to grow at 6 to 7% a year in Mexico as a whole, it is expected to grow at between 7 and 8% in the border region. The market for electric power generating equipment in Mexico has shown a growth rate of 9.5% over the last three years and represents a $400 to $500 million market per year. This could be used as a basis to predict the market for energy-related environmental equipment. However, purchases of such equipment are not as market driven. Environmental equipment usually requires a strong regulatory climate to stimulate sales. Additionally, much of the equipment used for pollution abatement in power plants has uses in other types of plants as well.

The overall market for air abatement equipment in Mexico is approximately $100 million a year with a growth rate of 15% annually. Therefore, a conservative estimate for energy-related pollution abatement equipment sales along the border is probably in the $ 50 to $100 million a year range with a growth rate of between 10% to 15% until 2000.

There is no effective way to determine market growth for the services-related industry. Yet, environmental consulting and engineering is one of the fastest growing segments along the border and in the interior of Mexico. Because services are often coupled with new projects and equipment sales, and because environmental audits and designs for major projects runs are integral parts of the project, the market for energy-related environmental services along the border is in the range of $5 million to $10 million per year with a growth rate of between 15 to 20%.

Competition. Currently power plant construction is dominated by Mexican construction and energy firms. However, U.S. firms on their own or in consortium with Mexican partners dominate the market in the border region. Many of the U.S. firms are divisions of U.S. utility companies and include Houston Power and Lighting, Southern Electrical International and Mission Energy.

Firms selling the environmental consulting services backing up these projects (energy audits, environmental audits, impact statements, engineering design, etc.) are also mainly U.S. firms (a large percentage are more specifically Texas firms).

U.S. firms are likely to see growing competition from foreign firms in the BLT area for cogeneration and waste to energy projects. This will be due to foreign firms' ability to bring long-term, low-interest rate financing to the projects. Competition will be strong from German firms, especially in the incineration of waste business. Also, German and Swiss firms have made inroads into the interior of Mexico in the air monitoring and abatement equipment sector, and there is no reason to think that they will stay away from the border region.

Buyer preference. As stated earlier, the environmental market along the border is dominated by U.S. companies. Preference for U.S. firms and services is due to the good reputation that such work enjoys along the border, familiarity with U.S. products, and the large presence of U.S.-owned facilities along the border.

Recommended strategy for entering the market. Firms wishing to work on large projects such as cogeneration or waste to energy should seek out Mexican partners who have good connections with the CFE and local authorities. Bidding on Mexican Government contracts is time consuming and difficult, and a Mexican partner can save a great deal of time, frustration and money. U.S. firms should also be prepared to bring financing for such projects.

Equipment manufacturers should seek out larger U.S. firms that are doing such projects as power plant design and construction. Additionally, they should approach U.S. firms located along the border from two directions; direct sales to facility managers and sales calls on the U.S. headquarters of the *maquiladoras*.

Industrial Air Pollution Control Market

Regulatory developments

- The enforcement of air emissions standards, especially at the state and local levels, is increasing
- New technical standards covering more industries are expected within the next six months to one year.
- Older technical standards have either been rewritten or are in the process of being rewritten; results have been an increase in stringency of maximum allowable levels.

Current investment. Government investment will be mainly in setting up air monitoring stations along the border and in research studies of air pollution along the border. The main buyers will by the National Institute of Ecology (INE) in Mexico, the U.S. EPA, and state agencies along both sides of the border. On the U.S. side, most of the communities have monitoring stations in place. On the Mexican side, stations have been or are being installed in Tijuana, Juarez, the Lower Rio Grande Valley, Nogales and the Imperial Valley-Mexicali area.

Due to increased enforcement along the border with regard to air emissions by industry, the biggest investments in this sector of the market will be made by factories with air emissions. This investment will be made in services (environmental audits and air emissions monitoring for yearly inventory requirements) and abatement (filtration and collection for VOCs, dust, etc.) and monitoring equipment (gas/particle sampling analyzers, metering instruments). Additionally, with growing emphasis on worker health and safety, more manufacturers will be considering respirators and various safety equipment.

Market estimates and projections. The private sector market for air emissions abatement equipment along the border is approximately $50 to $100 million a year with a growth rate of 10 to 15% per year. This will continue until the year 2000.

Competition. Currently, U.S. equipment and service firms dominate the government work that is being done along the border. However, Mexican joint-ventures with Canadian firms have been big competitors in the interior of Mexico. These firms have made the largest in-roads in the market through the sale of services. Often they have become known to Mexican authorities by assisting in the writing of the revised and new air technical standards.

Private sector sales are more pragmatic. The services industry (environmental engineering) catering to the private sector is dominated by U.S. firms, many of which are headquartered in Texas. Many firms along the border require on-going engineering consulting work; both for

environmental audits and for yearly air monitoring requirements. The majority of firms prefer to deal with engineering firms in the United States with which they have had previous relationships.

Buyer preference. Buyer preference along the border favors U.S. and U.S.- Mexican joint ventures in the services sector. U.S. equipment is favored, but there will be an increase in competition from German firms, which are held in high regard for the precision of their equipment.

Recommended strategy for entering the market. Any facility which has air emissions must submit an air emissions inventory each February. The required monitoring and analysis work for such paperwork must be done by an outside engineering firm. Such a firm must be licensed by SEDESOL to do such work. U.S. firms can be licensed by SEDESOL; however, it is much easier to acquire the necessary licenses if the U.S. firm is in an association or joint venture with a Mexican firm.

U.S. firms should contact facilities directly or through corporate headquarters. If choosing to work with a Mexican joint-venture partner, choose one who already has good relations with the *maquiladora* community. An additional clientele base is also developing with the larger Mexican-owned facilities along the border and clustered around Monterrey and Chihuahua. Due to increased enforcement in these two cities, many of the large Mexican-owned facilities are conducting environmental audits, energy efficiency studies and air monitoring.

Municipal and Industrial Water Pollution Control Market

Regulatory developments

- Increased enforcement of water regulations.
- Increased fees for water usage.
- Taxes on wastewater discharges based on level of maximum allowable levels (MAL).
- More stringent technical standards for MALs of most industries at both the federal and state levels.
- Emphasis on government's part to encourage the pretreatment of wastewater before its release by industry.

Current investment. This is one of the two main sectors slated for heavy investment in the border region. The U.S. Council of the Americas estimates that water/wastewater needs along the border for the period of 1993 to 2003 will total $5.1 billion dollars.[27] Most of this money will come from the World Bank, the Inter-American Development Bank and the new NADBank, as well as various other federal and state agencies on both sides of the border. Major water/wastewater projects along the border include:

- Tijuana International Wastewater Treatment Facility
  Joint funding project by the IDB, U.S. Government (SRF loan) and Mexican Government. Begun in 1993, three phase project: sewage works in Tijuana, land and ocean outfall in San Diego, and construction of 25 mgd secondary treatment plant in San Diego. Final price $200 million.

- Mexicali II Wastewater Treatment Plant
  Funding through IBWC. Design work and some construction began in 1993.

- Nogales Wastewater Treatment Plant
  Funding through IBWC. Construction work begun in 1992, plant expansion from 8.2 mgd to 17.2 mgd.

- Juarez Water Treatment Facility
  Funding through Mexican Government. Will probably receive additional funding via government from World Bank. Facility is still in design stage.

- Nuevo Laredo Wastewater Treatment Plant
  Joint funding through U.S., Mexican and Texas governments. Treatment facility to be completed by end of 1994. Final price $42 million.

These projects are in various stages of completion (design work is still going on in Tijuana and Mexicali; Nuevo Laredo is supposed to come on-line this year). However, most of these projects will be looking at expansion needs almost as soon as they are completed. Furthermore, there will be a need to design, fund and build collection systems.

Additionally, the Mexican Government has submitted a list of projects for funding by the NADBank. These projects include:

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27 See U.S. Council of the Americas, *Analysis*, 1993, p. 3.

- Wastewater treatment for Mexicali (besides project listed above). Estimated wastewater collection and treatment needs for Mexicali area $447 million.[28]

- Completion of the third phase of the canalization of the Rio Tijuana. No cost estimates (NCE)

- Wastewater treatment for Ojinaga. NCE

- Supplying of potable water to Juáraz through the Proyecto Conejos Médanos. NCE
- Wastewater treatment for Ciudad Acuña. NCE

These projects are still in the funding stage.

Additional investments will be made by private industry in two areas; in-house purification and pretreatment equipment, as well as various types of abatement and recycling equipment, and such projects as private treatment facilities for industrial parks, and BOT projects for municipalities.

One idea which may become common on the border is a project that industry proposed in Juarez. The larger *maquiladoras* in Juarez suggested financing their own treatment facility that would treat industrial wastewater from the plants which financed the project. Also, many of the industrial parks along the border are incorporating pretreatment and wastewater treatment facilities into their parks. They are doing this to induce industry into their parks and because of Mexican Government encouragement. This has been by both Grupo Argüelles (along the Texas border) and the Bustamante Group (California).

Market estimates and projections. Given the current needs of this market and the funding that will be coming on-line in both the public and private sectors, it is very likely that the border region will see a much higher annual growth rate in this sector than the rest of Mexico. Currently, the annual growth rate for water/wastewater equipment and services is 15%. However, due to the population and economic growth, as well as the availability of funds, the annual growth rate along the border will be closer to 20% up to the year 2000.

Competition. The strongest competition is coming from Mexican firms either on their own or in joint ventures with U.S. or other foreign firms. Such companies as Protexa, Bufete Industrial, and Grupo Impreserial de Mejor Ambiental are teaming with large U.S. construction/engineering firms such as Bechtel and M.W. Kellogg, to do projects throughout Mexico. These will be the major players for the water/wastewater projects which are being financed publicly along the

[28] See Council of the Americas, *Analysis*, 1993, p. 16.

border. Other companies to watch are Fluor Daniel, Brown & Root, and OMI, a unit of CH2M Hill.

There are also several strong foreign competitors beginning to do water/wastewater projects in Mexico. These are Cie. Generale des Eaux (French), Lyonnaise des Eaux-Dumez (French), Severn Trent (British), and North West Water (British). The French, in particular, pose a threat to U.S. companies doing business along the border. The French have developed a program for cost effectively doing BLT projects for municipalities to deliver water and sewer services. They are working on such projects in Aguascalientes and Mexico City, and also in the Southern part of the United States (Louisiana, Kentucky and California). This ability to do long-term projects and supply the up-front financing will make these firms very attractive to the municipal governments along the border.

Buyer preference. Currently, as with the other sectors highlighted above, the border region manufacturers and public officials have a preference for U.S. firms when looking for water/wastewater equipment and expertise. However, the French and British are recognized as offering high-quality equipment and services. It would not take much effort for these foreign competitors to displace the U.S. firms.

Recommended strategy for entering the market. Larger firms wishing to bid on major projects should consider associations or joint ventures with Mexican construction firms. There is a preference in Mexico to have as much local content as possible in construction projects and a Mexican partner can make the acquisition of building materials much easier. Additionally, a Mexican partner will understand the bidding procedure in Mexico and make the operation smoother.

Smaller firms should look for U.S. bidders on larger projects, should approach the U.S.-owned facilities along the border, and should consider a representative to assist in approaching the Mexican-owned facilities.

The best opportunities for services are in:

- design and construction of traditional treatment plants in the smaller communities on the border
- design and construction of traditional collection systems for smaller communities on the border
- BLT of municipal systems

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Smaller firms should look for U.S. bidders on larger projects, should approach the U.S.-owned facilities along the border, and should consider a representative to assist in approaching the Mexican-owned facilities.

The best opportunities for services are in:

- design and construction of traditional treatment plants in the smaller communities on the border
- design and construction of traditional collection systems for smaller communities on the border
- BLT of municipal systems

- environmental audits to reduce water usage and to minimize wastewater discharges for industry.

The best opportunities for equipment are in:

- Monitoring and testing equipment for public and private sector as awareness and enforcement increase. Includes stationary and portable analyzers and sampling equipment.

- Pre-treatment equipment for water for industry (in-house) until municipal delivery system is on-line.

- In-house treatment equipment to recycle, reduce and otherwise treat wastewater before discharge. Includes filter presses, settling tanks, screens and filters, osmosic systems.

- Supplying municipal projects. Includes aerators, chlorinating equipment, screens, and pumps.

Solid and Hazardous Waste Market

The solid waste problem along the Mexican side of the border verges on becoming a crisis. The majority of municipal landfills along the border are open dumps. Additionally, most are at capacity or overflowing. After water/wastewater, municipal garbage is the next major area slated for investment along the border.

Hazardous waste is also a growing problem along the border. There is only a rudimentary infrastructure to transport, recycle and dispose of hazardous industrial waste. While the *maquiladoras* are required to return their waste to the United States, the NAFTA and consequent reduction in tariffs on virgin chemicals will have a profound effect on the infrastructure that services this industry.

Regulatory developments.

- Revision of hazardous waste technical norms in 1993, resulted in more stringent MAL, handling and disposal procedures.

- More inspections on both federal and state level.

- Stiffer fines, more temporary and permanent closures, and closer scrutiny of paperwork.

Current investment. The biggest public investments will be in coping with the municipal waste problem along the border. The World Bank, the NADBank and the Mexican Government are each making major commitments of money to this sector along the border. Through the 1992 - 1994 period, the Mexican Government has slated funding for the following projects:

- sanitary landfills in Ciudad Juarez, $4 million
- sanitary landfill in Nogales, $1.8 million
- sanitary landfill in Nuevo Laredo, $2 million
- sanitary landfill in Reynosa, $2 million
- sanitary landfill in Matamoros, $2 million.

The Mexican Government has also asked for financing through the NADBank for the following projects:

- municipal solid waste project in Mexicali
- municipal waste project in San Luis Río Colorado
- municipal solid waste project in Piedras Negras
- additional solid waste project in Reynosa.

Sanitary landfill projects will be bid out by the municipalities where they are located. Funding will be through the federal government and the NADBank. This combination will probably cause some delay in these projects coming on-line. The beginning of 1995 is the earliest that RFPs could start being issued.

The Mexican Government has discouraged the development of recycling and disposal sites for hazardous waste along the border. This has come from a fear of Mexico becoming a dumping ground for U.S. waste. There is an infrastructure developing deeper in the interior. A hazardous waste landfill and several recycling facilities exist in and around Monterrey. Ultimately, as the border industry shifts from *maquiladoras* (which are expected to become Mexican corporations as NAFTA phases out their tariff advantages) to Mexican corporations, a link between the border region and the developing hazardous waste handling infrastructure will have to be made. It is most likely that trucking and recycling will be where industry makes the initial investments.

Because Mexico will follow the U.S. market trends, it is very likely that manufacturers will cut hazardous waste streams over the coming years. This reduction in hazardous waste will dry up any waste handling market that may have otherwise developed along the border.

Market estimates and projections. The strongest growth will be in the municipal waste collection and disposal market. Large amounts of financing have been committed to create an infrastructure for handling municipal waste along the border.

Competition. As with the other environmental industries, U.S. firms are very strong on the border region. Browning-Ferris Industries and Laidlaw (Canadian) are competing with regional waste management firms to service the municipal waste market along the border. There are also local Mexican firms that are developing. One example is the Arguellas Group in the Lower Rio Grande Valley.

The major U.S. player in the hazardous waste management industry in Mexico is Chemical Waste Management. In January 1994, ChemWaste bought the hazardous waste landfill in Monterrey. This is currently the only permitted hazardous waste landfill in the country (there is a privately held one in Sonora, but it is used only for the waste generated by the company which owns it). Another U.S. firm, Metal Clad of California, has bought another Mexican waste company, Quimica Omega, and the corporation was issued a permit in March to build a hazardous waste landfill in San Luis Potesi. It is also rumored that ChemWaste has received permission to build two hazardous waste landfills around Guadalaja.

Potential competition could arise from the Germans. This would most likely be in the waste to energy sector. However, until there is a more effective user fee system in place, it will be difficult to finance such projects along the border.

Buyer preference. U.S. and Mexican waste management firms.

Recommended strategy for entering the market. The major opportunities for the public sector will be in municipal garbage. The recommendations for entering this market are similar to those for entering the water/wastewater market.

The best opportunities for municipal waste are in:

- BOTs or private ownership for collection and landfilling
- consumer products for waste collection and recycling.

The best opportunities for hazardous waste are in:

- in-house waste pollution abatement equipment
- BOT or private ownership of disposal facilities (limited time)
- recycling of spent solvents for smaller manufacturers
- environmental audits to assist manufacturers in improving waste tracking, reducing waste streams, and handling final disposal.

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ATTACHMENT A

Seven major areas of industrialization exist along the border. The *maquiladoras* are the dominant industry on the Mexican side. Exhibit B-9 is a cluster study of five of these areas. The clusters are broken down by Mexican Industrial Class Code and by size of operation. Surveyed industries are those most likely to produce industrial air emissions, wastewater discharges and/or hazardous waste (industries that have no waste were excluded).

Exhibit B-9
Target Industries by Mexican Industrial Class Code

30 -	wood products Includes manufacture of furniture, floors, window frames, etc. Cleaning and finishing chemicals would be in use.
37 -	fiberglass & synthetic resins
42 -	plastics products Plastic injection molding procedures
45 -	mineral, marble & non-metallic products
46-50	Includes everything from metal pressing to construction. It would also include re-conditioning of motor parts and manufacture and/or assembly of motors, handles, furniture, or any other metals that would require cleaning, welding, etching, or soldering, thus requiring venting.*
46 -	iron & steel products
47 -	non-ferrous metals
48 -	metal furniture
49 -	metal structural products
50 -	other metal products*
54 -	electronic apparatus & equipment (production of circuit boards)
55 -	electric apparatus
57 -	automobile parts & accessories
60 -	construction (metal finishing, chrome plating, lacquering, printing, magnet tape)*

*Because of the broadness of the categories and because manufacturers could fit into several categories, for simplicity's sake, manufacturers were assigned to the category they were most involved in.
Source: Market Strategies International, Inc.

Exhibit B-10
Number of Maquiladoras by Industrial Code and Size in Each Cluster

CLUSTER 1

City	Code	SIZE OF COMPANY NUMBER OF EMPLOYEES "Small" < 100	"Medium" 100 - 400	"Large" > 400
Tijuana	30	45	12	2
	37	4		
	42	15	6	
	46	1		
	47	2		
	48	2		
	50	7	1	
	54	10	10	2
	60	5	3	
Ensenada	30	5		
	42	3		
	50		1	
	54	1		

CLUSTER 2

City	Code	SIZE OF COMPANY NUMBER OF EMPLOYEES "Small" < 100	"Medium" 100 - 400	"Large" > 400
Mexicali	30	2		
	42	4		
	48	1		6
	54	4	3	1
	59			
Tecate	30	12	3	
	37	4		
	42	4	1	
	45	2		
	50	9	1	
	54	21	3	
	55	2		
	57	2		
	59	3		
	60	1		1

CLUSTER 6

City	Code	SIZE OF COMPANY NUMBER OF EMPLOYEES "Small" < 100	"Medium" 100 - 400	"Large" > 400
Nuevo Laredo	28	1		
	30	2	1	1
	42	3	5	1
	46	10	4	3
	54	3	7	3
	60	1	3	

CLUSTER 8

City	Code	SIZE OF COMPANY NUMBER OF EMPLOYEES "Small" < 100	"Medium" 100 - 400	"Large" > 400
Matamoros	30	1		
	35	2		
	37	1		1
	39	1		
	42	7	2	
	47	2		
	50	5		
	54	6	7	1
	57			2

* In the Matamoros area the large firms tend to be really large -- all over 600 employees

CLUSTER 4

City	Code	SIZE OF COMPANY NUMBER OF EMPLOYEES "Small" < 100	"Medium" 100 - 400	"Large" > 400
Ciudad Juarez	37	1	1	1
	42	2	2	1
	43		1	
	50	2		
	54	4	10	14
	57		1	3
	59			1

APPENDIX C
CONTACT INFORMATION

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