Executive Summary

GREENHOUSE GAS EMISSIONS INVENTORY FOR THE STATE OF BAJA CALIFORNIA 2005

Prepared for:

ENVIRONMENTAL PROTECTION SECRETARY IN THE STATE OF BAJA CALIFORNIA

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BACKGROUND

Climate Change is presently considered one of the transcendental problems of the 21st Century and even as one of strategic security for all countries, as it threatens the sustainability of ecosystems and social development at a global level.

There is global concern regarding this problem. The United Nations Program for the Environment and the World Meteorological Organization formed the Intergovernmental Panel on Climate Change (IPCC) in 1988, which has worked tirelessly to foster, among other actions, the creation of emissions inventories in order to assess the present situation, estimate future impacts, and establish mitigation alternatives to stabilize the concentration of greenhouse gases to levels that can be captured in the biosphere.

Through the Intersecretarial Commission on Climate Change (ICCC), Mexico is carrying out actions to create public policy that will lead to mitigation and adaptation strategies aimed at reducing these emissions.

In October 2006, the Ministry of the Environment and Natural Resources (SEMARNAT,), through the National Institute of Ecology, published the National Greenhouse Gas Emissions Inventory 1990 – 2002 (INEGI-2002).

Given the strategic importance of having a Greenhouse Gas (GHG) Emissions Inventory for Baja California, the State Government, along with the Colegio de la Frontera Norte and the Mario Molina Center for Strategic Studies on Energy and the Environment, decided to develop an inventory using the year 2005 as a reference point.

Thus, the purpose of this first state inventory is to be a useful tool for decision-making, scientific research,and identification of opportunities to mitigate greenhouse gas emissions.

GHG Emissions Inventory

Quantification of GHG emissions for the State of Baja California was performed based on the methodological recommendations that were updated and unified in 2006 by the IPCC for the creation of national inventories. As is required by this methodology, emissions are calculated for four categories or emission source groups, which are:

1. Energy
2. Industrial Processes and Product Usage
3. Agriculture, Forestry and Land Use Change

4. Waste

The GHG inventory was based on the year 2005, because the geographic information and state data for this year were considered as the most complete and updated. After analyzing the available documented information at the state level, decision trees were developed for each category, which is the procedure suggested by the IPCC for determining the level of methodological complexity to be used. According to this tool, the present emissions inventory is categorized as level 1 or Tier 1, since, in general, emission factors predetermined by the IPCC were applied, although in some cases it was possible to use estimated factors for Mexico, which are referred to in the 1990-2002 NGGEI, specifically for the year 2002.

Quantified GHGs were carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), as well as fluorinated gases, the latter are mainly used in refrigeration systems and air conditioning equipment. For addition purposes, the estimated amounts of the aforementioned gases were standardized to gigagrams (Gg-1000 grams) of CO_2 equivalent for a 100-year period.

The following chart shows the amount of GHG released by each sector according to its original emissions and its equivalent in CO_2**,** whose approximate generation for the year 2005 in Baja California was estimated at **17,684 Gg**.

GHG EMISSIONS IN BAJA CALIFORNIA
2005

Category	CO_2	CH_4	N_2O	Fluorinated Gases	Total.
	Gg			Gg, CO_2 equiv	Gg CO_2 equiv
Energy	13,471.91	8.28	1.104	---	13,988.11
Industrial Processes	390.40	---	---	50.43	440.83
Agriculture, Forestry and Change in Land Use	---	21.22	1.72	---	979.58
Waste	---	105.71	0.18	---	2,275.92
Total emissions by type of GHG	**13,862.31**	**135.21**	**3.00**	**50.43**	**17,684.44**

SOURCE: Prepared by MMC, 2007.

1. ENERGY

This category represents the greatest contribution to GHG emissions with 79% of the total emissions in the state, taking into consideration only fuel consumption by the following sub-sectors: power generation, transportation, industry, residential and services, and farming and animal husbandry (agriculture), classified as fixed and mobile combustion sources.

By far, the main direct consumers of fossil fuels are power generation and transportation, 48% and 43% respectively. The industry sector and the residential and services sector consume close to 8.8%, however, indirectly, they represent a high consumption rate of electric power, mainly due to the use of air-conditioning equipment in the summer and heating in the winter in order to adapt to the climate conditions of the state. The farming and animal husbandry sector consumes only approximately 0.2%.

ENERGY USE IN BAJA CALIFORNIA 2005

Sector	Use PJ/year	%	Total Gg CO_2 equivalent
Electric Power Generation	105.11	48.10	4,817.46
Transportation	93.80	42.92	6,995.37
Industry	7.84	3.59	500.56
Residential and services	11.31	5.18	1,646.11
Agriculture	0.46	0.21	28.60
Total	**218.52**	**100**	**13,988.11**

SOURCE: Prepared by the MMC, 2007 based on information from the Energy Information System, using information from the Survey on Power Usage in the Industrial Sector, SENER, 2005.

For 2005, this power usage generated total emissions close to 14 thousand Gg of CO_2 equivalent; power generation and transportation are responsible for 84% of emissions in this category. It is worth mentioning that the transportation sector is the main source of GHG at the state level and it shows an accelerated growth rate in the absence of fuel efficiency regulation, especially highway transportation, which in the last decade has had a significant increase in the use of low fuel efficiency trucks, pick-ups and SUVs.

2. INDUSTRIAL PROCESSES

Because there are no state statistics for processes and substances used in the manufacturing process and in the use of industrial and residential goods, there is less information available to estimate emissions originating from this category. This information is essential to estimate GHG emissions that do not originate from combustion, such as HCFCs used in refrigeration and air-conditioning units, or sulfur hexafluoride (SF_6), used as an isolation gas in the electricicty generation industry.

Today, many gases, such as HCFC, CFC, HFC, SF_6 – among others, are substitutes for others that damage the ozone layer; however, they have a high global warming potential, and therefore, it is necessary to regulate them.

According to estimates using information from the Electrical Energy Savings Trust (FIDE) and the Ozone Layer Protection Unit from SEMARNAT, emissions originating from leaks in refrigerators and air-conditioners used in homes and vehicles in Baja California contribute a total of 50.43 Gg of CO_2 equivalent; this number does not take into account emissions generated during the manufacturing process of this equipment.

EMISSION OF FLUORINATED GASES DUE TO REFRIGERATION AND AIR-CONDITIONING IN BAJA CALIFORNIA 2005

Compound	Refrigerators and air-conditioning units in homes (Kg HCFC/year)	Air-conditioning Units in vehicles (Gg CO_2/year)	Total (Gg CO_2 equiv)
HCFC-22*	28,175.06	---	47.89
HFC-134	---	2.53	2.53
TOTAL	**28,175.06**	**2.53**	**50.43**

** Global Warming Factor for HCFC-22 = 1,700*
SOURCE:Prepared by MMC, 2007 based on information from FIDE, 2007.

Emissions generated by other specific processes in industries that are located in Baja California, such as the production of clinker in the cement industry. food and beverage (bread and beer) manufacturing, and the iron and steel manufacturing industry, totaled 440.83 Gg of CO_2 equivalent in 2005.

GHG EMISSIONS FROM INDUSTRY IN BAJA CALIFORNIA 2005

Type of Industry	Total (Gg CO_2 equiv.)
Cement	227.75
Food and Beverage	70.01
Steel	92.60
Refrigeration and air-conditioning	50.43
Viticulture and Wine Production	0.04
Total	**440.83**

SOURCE:Prepared by MMC, 2007.

3. AGRICULTURE, FORESTRY AND LAND USE CHANGE (USSCUS)

Quantification of methane (CH_4) and nitrous oxide (N_2O), which are the main GHGs generated by primary activities – agriculture, farming and animal husbandry, forestry – originate from

enteric fermentation and manure management, agricultural burnings and changes in the use of agricultural lands.

Enteric fermentation is the natural digestive process in herbivores (ruminants such as cattle and sheep and some non-ruminants such as pigs and horses); however, it is the main source of methane generation and it depends on the type, age and weight of the animal as well as on the quantity and quality of the fodder the animals have ingested.

In 2005, Baja California had a total of 1,460,343, of which 84.4% were farm fowl and only 3.7% were cattle.

ANIMALS
2005

Type of Animals	Num. Animales (head)	%
Farmfowl	1,232,086	84.4
Goats/Billygoats	117,182	8.0
Pigs	12,231	0.8
Other cattle	17,582	1.2
Sheep	26,935	1.8
Cows	54,327	3.7
TOTAL	**1,460,343**	**100**

SOURCE: SAGARPA, 2007.

Land use changes represent an important factor for GHG emissions because deforestation or transformation of forests into farming lands or animal husbandry lands, or abandoning the lands causes a significant reduction in the amount of emitted carbon dioxide that is captured.

The state has a total of 680,000 hectares of forest land, however, during 2005, 680 hectares were used for human settlement and more than 23,600 hectares were in transition for different uses.

FOREST AREAS AND LAND USE CHANGE
2005

Parameter	Baja California (ha)
Remaining forest lands	680,009
Surface area turned into settlements	-680
Land in transition for other uses	-23,600
Estimated Loss of Land	-24,280

SOURCE: SAGARPA, 2005.

In all of Baja California, this activity contributes 5.5% to the emissions generated by the state, with a total of 979.58 Gg of CO_2 equivalent, which originates mainly from manure management, which releases nitrous oxide (N_2O).

GHG EMISSIONES AND
AGRICULTURE, FORESTRY AND LAND USE CHANGE
2005

Category of emissions	CH_4	N_2O
	Gg	
Enteric Fermentation and manure management	21.22	---
N_2O directly from manure management systems	---	1.72
N_2O indirectly from manure management	---	4.19×10^{-3}
Biomass burning in forest lands (Forest areas maintained as such)	4×10^{-5}	3.9×10^{-7}
Biomass burning in farmlands (Farmlands maintained as such)	2.5×10^{-5}	7×10^{-6}
Biomass burning in lands used for activities other than farming (Farmlands maintained as lands used for activities other than farming)	2.9×10^{-5}	7×10^{-7}
SubTotal (GHG Gg)	21.22	1.72
Gg of CO_2 equivalent	**445.72**	**533.86**
TOTAL	**979.58** Gg CO_2 equiv	

SOURCE:Prepared by MMC, 2007.

4. WASTE

The estimation of GHG in this category included the generation caused by management and disposal of municipal solid waste (MSW), as well as municipal and industrial wastewater treatment both of which produce significant amounts of methane (CH_4) and nitrous oxide (N_2O).

In 2005, 1.163 million tons of waste were generated, from which 1.119 million tons were disposed of, that is, 96.2% of the total amount. From this percentage, 72.4% was disposed of in landfills, (controlled sites) and 27.6% in open air dumps (uncontrolled sites).

Most of the emissions generated by this sector are from food waste, which represents 44% of the total waste generated in the state. Other kinds of contributing wastes are from parks and yards, paper and cardboard, as well as wood, textiles and disposable diapers.

In 2005, Baja California had a total of 5 landfills, 2 hazardous waste confinement (controlled) sites and 2 open-air dumps, of which 2 are presently inactive (a landfill in Ensenada and a hazardous waste confinement site in Mexicali).

In 2005, 195,000,000 cubic meters of potable water were distributed of which 144,000,000 were collected as wastewater, equivalent to close to 74% of the total water distributed. There were 26 wastewater treatment plants in the state, with an installed capacity of 5.64 m^3/s, and a treated volume of 123.2 million m^3/year; the most prevalent types of treatment were oxidation ditches and ponds, and activated sludge.

For industrial wastewater treatment there were 179 plants with a capacity of 0.39 m^3/s; the total volume that was treated in 2005 was 12,000,000 $m^{3.}$

This sector contributed a total of 2,275 Gg of CO_2 equivalent, representing 12.8% of the total emitted in 2005.

GHG EMISSIONS FROM WASTE IN BAJA CALIFORNIA 2005

Category	Gg CH_4/year	Gg N_2O/year	Gg equiv CO_2 /year
Solid Waste*	88.63	N.A	1861.16
Wastewater*	17.09	0.18	414.27
		TOTAL	**2,275.43**

** Includes Municipal and Industrial; N.A., Not Applicable*
SOURCE:Prepared by MMC, 2007.

5. CONCLUSIONS

Because of Baja California's geographic location, its climate is extreme semi-arid, which causes 90% of the population to concentrate in the cities of Tijuana, Rosarito and Mexicali. These urban areas are located along the border region, whereas the rest of the state is practically uninhabited and has very few activities that generate GHG. The per-capita emissions of GHG for the year 2005 due to waste were 0.8 tons; this amount is by far higher than the reported national level – 0.65 tons in the year 2002.

On the other hand, because of Baja California's weather and vicinity to the United States of America, the patterns of energy use are higher than the average national levels, especially because of the use of air-conditioning and heating units in summer and winter, respectively. This is quite clear when comparing the per-capita emissions in the national energy sector, which reported 3.86 tons/inhabitant in the year 2002 compared to the state's levels, which are close to 4.92 tons/inhabitant in 2005.

The following chart compares the contribution by GHG category in Baja California for the year 2005 relative to the reports from NGGEI at a national level for the year 2002. It is possible to estimate that the State of Baja California contributes less than 3% to the national inventory.

It is worth noting that the annual national per-capita emissions were approximately 6.37 tons of CO_2 equivalent in 2002, when the estimated population was 101 million inhabitants, while in Baja California the value was close to 6.22 tons in 2005 and the population was 2.84 million inhabitants.

COMPARISON
BAJA CALIFORNIA 2005 *vs.* MEXICO 2002

CATEGORY	Baja California 2005*		Mexico 2002*	
	Gg CO_2 equivalent	%	Gg CO_2 equivalent	%
Energy	13,988	79%	389,497	61%
Industrial Processes	441	2%	52,102	8%
Agriculture, Forestry and Land Use Change	980	6%	136,000	21%
Waste	2,275	13%	65,584	10%
TOTAL	**17,684**	**100**	**643,183**	**100%**

**Data are rounded out for comparison purposes.*
SOURCE:Prepared by the MMC using information from the 1990-2002 NGGEI, 2007.

6. KEY SOURCES

Key sources are determined in order to identify which categories in each sector have the greatest influence in GHG emissions in absolute levels, trends, or the uncertainty of emissions. Following is the estimate of key sources per category for the State of Baja California for the year 2005:

KEY SOURCES IN BAJA CALIFORNIA, 2005

Assessment by Levels (IPCC, 2006)						
Category	**Sector**	**GHG**	**Emissions in the baseline year**	**Emissions in the present year**	**Level Assessment**	**Level Assessment Accumulated Total**
2005			Gg CO_2 eq.	Gg CO_2 eq.		
Vehicle Transportation	Energy	CO_2	5,893.44	5,893.44	33.33%	33.33%
Power Generation	Energy	CO_2	4,802.71	4,802.71	27.16%	60.48%
Solid Waste Disposition	Waste	CH_4	1,861.23	1,861.23	10.52%	71.01%
Residential and Services	Energy	CO_2	1,599.58	1,599.58	9.05%	80.05%
Manure Management	USCUSS	N_2O	533.86	533.86	3.02%	83.07%
Industrial Combustion (other)	Energy	CO_2	497.46	497.46	2.81%	85.88%
Air Transportation	Energy	CO_2	489.51	489.51	2.77%	88.65%
Enteric Fermentation	USCUSS	CH_4	349.12	349.12	1.97%	90.63%
Vehicle Transportation	Energy	N_2O	287.03	287.03	1.62%	92.25%
Municipal Wastewater	Waste	CH_4	263.97	263.97	1.49%	93.74%
Cement	Industry	CO_2	227.75	227.75	1.29%	95.03%
Maritime Transportation	Energy	CO_2	160.65	160.65	0.91%	95.94%

SOURCE:Prepared by MMC, 2007.

7. RECOMMENDATIONS

The following are the main recommendations by category, which will improve Baja California's GHG emissions inventory in the future:

ENERGY

- Create a detailed energy balance at the State level.
- Carry out an industry census at the State level to identify the types of technologies used for fuel combustion according to their production processes, specifying whether the energy is from co-generation.
- Create a detailed census of mobile combustion sources that should include:
    a. Characterization of the vehicle fleet by type, year, model, technology, and fuel used.
    b. Activity data relative to the number of traveled kilometers and kilometers per liter according to the type of vehicle and fuel used.
- Determine the specific use of fuels in the State.
- Define specific emission factors for the State.

INDUSTRIAL PROCESSES

- Based on the industry census, identify production processes that directly or indirectly use substances or gases that have global warming potential. These substances might be used for the transformation of raw materials, or as part of the finished product.
- Promote and provide incentives for voluntary programs for reporting GHGs, such as the State Emissions and Pollutants Transfer Registry (RETC) established by SEMARNAT and/or the GHG Program promoted by the Private Sector Research Center for Sustainable Development (CESPEDES).

AGRICULTURE, FORESTRY, FARMING AND ANIMAL HUSBANDRY, AND LAND USE CHANGE

Periodically and systematically perform satellite monitoring to determine land use change in the State.

- Create historic records on agricultural production and farm animal species.
- Quantify nitrogenated fertilizer use, such as urea and ammonia in the Mexicali Valley and the agricultural lands in *San Quintin, San Vicente, Maneadero, Valle de Guadalupe, Ojos Negros* and *Valle de la Trinidad* in Ensenada and *Valle de las Palmas* in Tecate.
- Create a Registry of abandoned farmlands in *Valle de Camalu, Col. Guerrero* and *San Quintin* in the municipality of Ensenada.
- Create computerized and satellite records of forest fires and affected areas.
- Create biomass measurements – updating animal husbandry indices – and population density measurements by zones and ecosystems.

- Request information of seizures performed by federal environmental authorities insofar as unlawful logging and extraction of other forest species in the forests of the *San Pedro Martir* and *Juarez Sierras*.

WASTE

- Create an annual registry of disposed municipal and industrial solid waste, as well as the type of final treatment.
- Create a database of open-air incineration and burning of regulated solid waste.
- Establish an emissions control program for methane generated in landfills to prevent release into the atmosphere.
- Identify and quantify wastewater discharges according to the type of industry and production process.
- Carry out detailed studies to characterize solid waste and wastewater. These studies must contain control parameters that require the use of the methodology recommended by the IPCC 2006 (for example, average per-capita protein consumption).