Mexico National Emissions Inventory, 1999:

Six Northern States

FINAL

SECRETARÍA DE MEDIO AMBIENTE Y RECURSOS NATURALES | SEMARNAT

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MEXICO NATIONAL EMISSIONS INVENTORY, 1999: SIX NORTHERN STATES

FINAL

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Disclaimer

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ACRONYMS

ALVW	Alternative Loaded Vehicle Weight
ANAFAPYT	Asociación Nacional de Fabricantes de Pinturas y Tintas (National Association of Paint and Dye Manufacturers)
ARB	Air Resources Board
ASA	Aeropuertos y Servicios Auxiliares (Airports and Auxiliary Services)
BAC	Binational Advisory Committee
bbl	barrels
BELD	Biogenic Emissions Landcover Database
CANACINTRA	Cámara Nacional de la Industria de la Transformación (National Chamber of the Manufacturing Industry)
CANALAVA	Cámara Nacional de la Industria de Lavanderías (National Chamber of the Dry Cleaning Industry)
CANIPEC	Cámara Nacional de la Industria de Perfumería y Cosmética (National Chamber of the Cosmetics and Perfume Industry)
CAS	Chemical Abstract Service
CEC	Commission for Environmental Cooperation
CEIDARS	California Emissions Inventory Development and Reporting System
CENICA	Dirección General del Centro Nacional de Investigación y Capacitación Ambiental (General Director of the National Center for Environmental Research and Training)
CICA	Centro de Información Sobre Contaminación del Aire Para la Frontera entre EE.UU. y México (U.S. – Mexico Border Information Center on Air Pollution)
CICOPLAFEST	Comisión Intersecretarial para el Control de Plaguicidas, Fertilizantes y Substancias Tóxicas (Interagency Commission for Control of Pesticides, Fertilizers, and Toxic Substances)
CMAP	Catálogo Mexicano de Actividades y Productos) Mexico's Catalog of Activities and Products)
CNA	Comisión Nacional del Agua (National Water Commission)
CNBV	could not be verified
CO	carbon monoxide

CO_2	carbon dioxide
COA	Cédula de Operación Anual (Annual Operating Report)
DATGEN	Datos Generales
DF	Distrito Federal (Federal District)
DQOs	data quality objectives
EIIP	Emission Inventory Improvement Program
ERG	Eastern Research Group, Inc.
ft^3/year	cubic feet per year
g	gram
gal	gallon
GDF	Gobierno del Distrito Federal (Government of the Federal District)
GEM	Gobierno del Estado de México (Government of the State of Mexico)
GIS	geographical information system
GloBEIS3	Global Biosphere Emission and Interactions System Version 3
gr/ft	gram per foot
GVWR	gross vehicle weight rating
GW-hr	gigawatt-hours
HC	hydrocarbon
HDDV	Heavy-Duty Diesel Vehicles
HDGV	Heavy-Duty Gasoline Vehicles
hp	horsepower
hr	hour
I/M	inspection/maintenance
IC	internal combustion
ICAO	International Civil Aviation Organization
IMIP	Instituto Municipal de Investigación y Planeación
IMP	Instituto Mexicano de Petróleo (Mexican Petroleum Institute)

INE	Instituto Nacional de Ecología (National Institute of Ecology)
INEGI	Instituto Nacional de Estadística, Geografía e Informática (National Institute of Statistics, Geography, and Computing)
IPP	Inventory Preparation Plan
ISO	isoprene
ITESM	Instituto Tecnológico y de Estudios Superiores de Monterrey
kg	kilogram
km	kilometers
kmph	kilometers per hour
LAU	Licencia Ambiental Única (Single Environmental License)
lbs	pounds
LDDT	Light-Duty Diesel Trucks
LDDV	Light-Duty Diesel Vehicles
LDGT	Light-Duty Gasoline Trucks
LDGV	Light-Duty Gasoline Vehicles
LGEEPA	Ley General del Equilibrio Ecológico y la Protección al Ambiente (The General Law of Ecological Balance and Environmental Protection)
LPG	Liquefied petroleum gas
LTO	landings-and-takeoffs
LVW	Loaded Vehicle Weight
M	moisture content
m^3	cubic meters
MC	Motorcycles
mg	milligrams
Mg	megagrams
min	minute
NAICS	North America Industry Classification System

NARAP	North American Regional Action Plan
NCDC	National Climatic Data Center
NEI	National Emissions Inventory
NFB	National Fuels Balance
NH_3	ammonia
NH_4NO_3	ammonia nitrate
$(NH_4)_2SO_4$	ammonia sulfate
NIF	National Emissions Inventory Input Format
NM	Norma Mexicana (Mexican Standard)
NMOC	nonmethane organic compound
NO	nitric oxide
NO_2	nitrogen dioxide
NOM	Norma Oficiales Mexicanas (Mexican Official Standards)
NO_x	nitrogen oxides
OVOC	other VOC species
PAR	photosynthetically active radiation
PEMEX	Petróleos Mexicanos
PM	particulate matter
$PM_{2.5}$	particulate matter less than 2.5 micrometers in equivalent aerodynamic diameter.
PM_{10}	particulate matter less than 10 micrometers in equivalent aerodynamic diameter
PRTR	Pollutant Releases and Transfers Register (Registro de Emisiones y Transferencia de Contaminates)
QA	quality assurance
QAP	quality assurance plan
QC	quality control

RETC	Registro de Emisiones y Transferencia de Contaminates (Pollutant Releases and Transfers Register)
RVP	Reid vapor pressure
SAGARPA	Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food)
SCC	source classification code
SCERP	Southwest Center for Environmental Research and Policy
scf	standard cubic foot
SCT	Secretaría de Comunicaciones y Transportes (Secretariat of Communications and Transport)
SEA	state environmental agency
SEMARNAT	Secretaría de Medio Ambiente y Recursos Naturales (Secretariat of the Environment and Natural Resources)
SENER	Secretaría de Energía (Secretariat of Energy)
sL	silt loading
SMN	Servicio Meteorológico Nacional (Mexican National Weather Service)
SNIFF	Sistema Nacional de Información de Fuentes Fijas (National Information System of Point Sources)
SO_2	sulfur dioxide
SO_3	sulfur trioxide
SO_4^{2-}	sulfate
SO_x	sulfur oxides
TAC	Technical Advisory Committee
TCEQ	Texas Commission on Environmental Quality
TDMS	travel demand models
THC	total hydrocarbon
TIM	time-in-mode
TMT	total monoterpenes

TOC	total organic compounds
TOG	total organic gases
TSP	total suspended particulate
U.S. EPA	United States Environmental Protection Agency
UAM	Universidad Autónoma Metropolitana (Metropolitan Autonomous University)
UNAM	Universidad Nacional Autónoma de México (National Autonomous University of Mexico)
UTM	Universal Transverse Mercator
VKT	vehicle kilometers traveled
VOC	volatile organic compound
WGA	Western Governors' Association
WRAP	Western Regional Air Partnership
ZMVM	Zona Metropolitana del Valle de México
µm	micrometer

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The Binational Advisory Committee guided the overall development of the Mexico NEI. The members of the BAC are:

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1.0 INTRODUCTION

This report is the second of four reports to be published containing the Mexico National Emissions Inventory (NEI) for 1999. The Mexico NEI contains estimates of nitrogen oxides (NO_x), sulfur oxides (SO_x), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter less than 10 micrometers (µm) in aerodynamic diameter (PM_{10}) and less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$), and ammonia (NH_3) emissions for the year of 1999. This report contains final emissions estimates for the six northern Mexican states of Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas at the municipality level. The third “draft final” report will contain the interim emissions inventory for the entire country (i.e., 6 northern states and the remaining 25 Mexican states, plus the Federal District) at the municipality level. The fourth and “final” report will contain the final emissions inventory for the entire country for all sources of air pollution occurring in 1999.

Title IV of the General Law of Ecological Balance and Environmental Protection (*Ley General del Equilibrio Ecológico y la Protección al Ambient*e – *LGEEPA*) establishes the regulatory framework for Mexico’s air quality program. Article 111 of Title IV requires that the Secretariat of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales – SEMARNAT*) develop and periodically update an air emissions inventory of the pollutant sources under federal jurisdiction. Also, SEMARNAT must coordinate with state and municipal governments to integrate regional inventories and a national inventory. The National Institute of Ecology (*Instituto Nacional de Ecología – INE*), as the research entity within SEMARNAT, is the lead agency for development of this first Mexico NEI. Maintaining and updating the Mexico NEI is the responsibility of SEMARNAT’s Under-Secretariat of Environmental Management (*Subsecretaría de Gestión para la Protección Ambiental*).

1.1 Objectives

The objectives and end uses of the Mexico NEI were identified by many governmental, environmental, and private entities (stakeholders). The main objectives of the Mexico NEI are to provide the technical basis for improved air quality analyses within Mexico and on both sides of its borders, to support institutional capacity for developing emissions inventories within INE and SEMARNAT, to assist with regional haze requirements in the U.S., and to support the development of a tri-national emissions inventory of criteria pollutants for Mexico, the U.S., and Canada. In order the satisfy these objectives, the main goals of the Mexico NEI were established as follows:

- Develop a first-time national Mexico inventory using the highest quality Mexico-specific data available;
- Estimate 1999 annual emissions on the state- and municipality-levels; and
- Identify and compile data and determine methods for improving spatial and temporal resolution of the annual inventory in the future.

These goals were achieved through the financial, technical, and managerial support of the Western Governors' Association (WGA), the U.S. Environmental Protection Agency (U.S. EPA), and the North American Commission for Environmental Cooperation (CEC). More details on the Mexico NEI project participants, as well as developmental methodology, are described in the Inventory Preparation Plan (IPP) (ERG, 2003a).

1.2 Other Mexican Emissions Inventories

Other metropolitan- and regional-scale inventories have been conducted in Mexico for purposes of air quality planning and assessments. Several of these inventories, which are listed below according to their geographic area and base year, provided building blocks for the Mexico NEI:

- Mexico City Metropolitan Area and Valley of Mexico, 2000 (GDF, 2003);
- Guadalajara, 1995 (GJ, 1997);
- Monterrey, 1995 (GNL, 1997);
- Ciudad Juárez, 1996 (GCh, 1998);
- Toluca, 1996 (GM, 1997);
- Mexicali, 1996 (GBC, 1999);
- Tijuana, Tecate, and Rosarito, 1998 (GBC, 2000);
- State of Tabasco, 2000 (GT, 2003); and
- National Power Plant Inventory, 1999 (SENER, 2003).

The main use of these inventories is for the information they contain pertaining to industrial sources. As additional inventories are developed by SEMARNAT and other government agencies in Mexico for purposes of regional air quality planning (e.g., Salamanca, Guanajuato in May 2004), their content should be integrated into the Mexico NEI.

1.3 Related Technical Reports and Studies

Prior to, and since, the Mexico NEI project began in June 2000, there have been other Mexico emissions inventory projects conducted (or are currently underway) which resulted in tools or Mexico-specific data very important to the development of the Mexico NEI. Several of these tools and data are described below.

The Mexico Emissions Inventory Program Manuals were developed to provide guidance to agencies and industry when developing inventories in Mexico. For example, the Volume V Area Source Manual (Radian, 1997) contains many Mexico-specific methods and emission factors that were used for the Mexico NEI. Also, the Mexico Volume VII Natural Source Manual (ERG, 2002a) was used to estimate naturally occurring VOC and NO_x emissions from vegetation and soils in Mexico. All volumes of these manuals can be downloaded from the INE website at www.ine.gob.mx or from U.S. EPA's Information Center for Air Pollution on the U.S./Mexico Border (*Centro de Información sobre Contaminación de Aire* – *CICA*) website at www.epa.gov/ttn/catc/cica/.

The MOBILE6-Mexico emission factor model was developed for use in estimating emissions from on-road mobile sources (i.e., private automobiles, taxis, buses, and trucks) in Mexico (ERG, 2003b). This model was adapted from the U.S. EPA MOBILE 6.2 model using Mexican vehicle emissions test data collected in Mexico, as well as other Mexico-specific information. Section 5.0 of this report describes in detail how MOBILE6-Mexico was used in the Mexico NEI.

The NONROAD-Mexico model is currently being developed for use in estimating emissions from nonroad mobile sources (i.e., construction and agricultural equipment) in Mexico. This model will be adapted from the U.S. EPA's NONROAD2002 model using data collected from the construction industry and Mexico's Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación – SAGARPA*). (In lieu of the NONROAD-Mexico model, an alternative methodology was used for the Mexico NEI; see Section 6.0 of this report.)

Another task associated with the Mexico NEI provided important data for accurately estimating dust emissions from vehicle travel on paved and unpaved roads (i.e., reentrainment) in Mexico. This task focused on estimating the vehicle kilometers traveled (VKT) on paved and unpaved roads as a percentage of total roadway travel. Satellite images and aerial orthographic photographs were analyzed for certain cities in Mexico determined to be indicative of all cities based on population and demographics. Section 4.0 of this report describes in detail how these data were used to estimate reentrainment emissions in the Mexico NEI.

1.4 Organization of this Report

This report provides background to the development of the Mexico NEI, describes methods used and results for each source type (i.e., point, area, mobile, nonroad, and natural source types), analyzes the results by comparing estimates between states and source types, and makes recommendations for improving the inventory in the future.

An important point should be noted regarding this report. This report contains final emissions estimates for the six northern Mexican states, only. Although it is referred to as the Mexico "national" emissions inventory, at this time the inventory contains emissions for six states. Subsequent reports will contain emissions for all 32 states including the Federal District.

The contents of the Mexico NEI report are organized as follows:

- **Section 1.0 – Introduction.** This section provides the background on the development of the Mexico NEI, including regulatory authority of SEMARNAT/INE, inventory objectives, other Mexico emissions inventories, and development of tools and special data used in the Mexico NEI.
- **Section 2.0 – Scope and Process.** This section describes the inventory characteristics (i.e., pollutants, sources, geographical coverage), how quality goals for emissions estimates were assessed, Mexico NEI data management procedures, and important issues affecting future updates to the Mexico NEI.

- **Section 3.0 – Point Source Emissions.** This section describes the methodology used and results of the industrial emissions inventory for Mexico. Total emissions by state and pollutant are explained, as well as relative emissions (percentage) by source category.

- **Section 4.0 – Area Source Emissions.** This section describes the methodologies used and results of the area source emissions inventory for Mexico. Total emissions by state and pollutant are explained, as well as relative emissions (percentage) by source category.

- **Section 5.0 – Motor Vehicle Emissions.** This section describes the methodology used and results of the emissions inventory for on-road motor vehicles in Mexico. Total emissions by state and pollutant are explained, as well as relative emissions (percentage) by source category.

- **Section 6.0 – Nonroad Mobile Source Emissions.** This section describes the methodology used and results of the emissions inventory for construction and agricultural equipment. Total emissions by state and pollutant are explained, as well as relative emissions (percentage) by equipment type.

- **Section 7.0 – Natural Source Emissions.** This section describes the methodology used and results of the emissions inventory of natural sources (i.e., VOC emissions from vegetation and NO_x emissions from soil). Total emissions by state and pollutant are explained.

- **Section 8.0 – Analysis of Results.** This section discusses and analyzes the national emissions inventory based on state level estimates by pollutant. Recommendations are made for future improvements to the Mexico NEI and are presented in order of priority based on opportunities to increase confidence in the most significant sources.

- **Section 9.0 – References.** All data, reports, technical memoranda, and other sources of information used in the development of the Mexico NEI are listed.

- **Appendix A – Technical Memoranda:** This appendix contains important technical memos documenting ancillary research conducted in support of the Mexico NEI.

- **Appendix B – Additional Point Source Data.** This appendix contains detailed information used to estimate point source emissions.

- **Appendix C – Additional Area Source Data.** This appendix contains detailed information used to estimate specific area source categories.

- **Appendix D – Additional Motor Vehicle Source Data.** This appendix contains detailed information used to estimate onroad motor vehicle emissions.

- **Appendix E – Additional Nonroad Mobile Source Data.** This appendix contains detailed information used to estimate agricultural and construction equipment emissions.

- **Appendix F – Additional Natural Source Data.** This appendix contains detailed information used to estimate natural source emissions.

- **Appendix G – State Level Emissions Inventory Summaries.** This appendix contains printouts of emissions estimates by source type for each of the six northern Mexican states.

- **Appendix H – Municipality Level Emissions Inventory Summaries.** This appendix contains printouts of emissions estimates by source type for each of the 276 municipalities located within the six northern Mexican states.

2.0 SCOPE AND PROCESS

This section describes four important characteristics of the Mexico NEI: geographic domain, base year, pollutants, and source types. Also, relevant procedural steps are described including data management and quality assurance. Last, several factors affecting future versions of the Mexico NEI are discussed such as mandatory emissions reporting for industrial sources.

2.1 Inventory Characteristics

2.1.1 Geographic Domain and Spatial Resolution

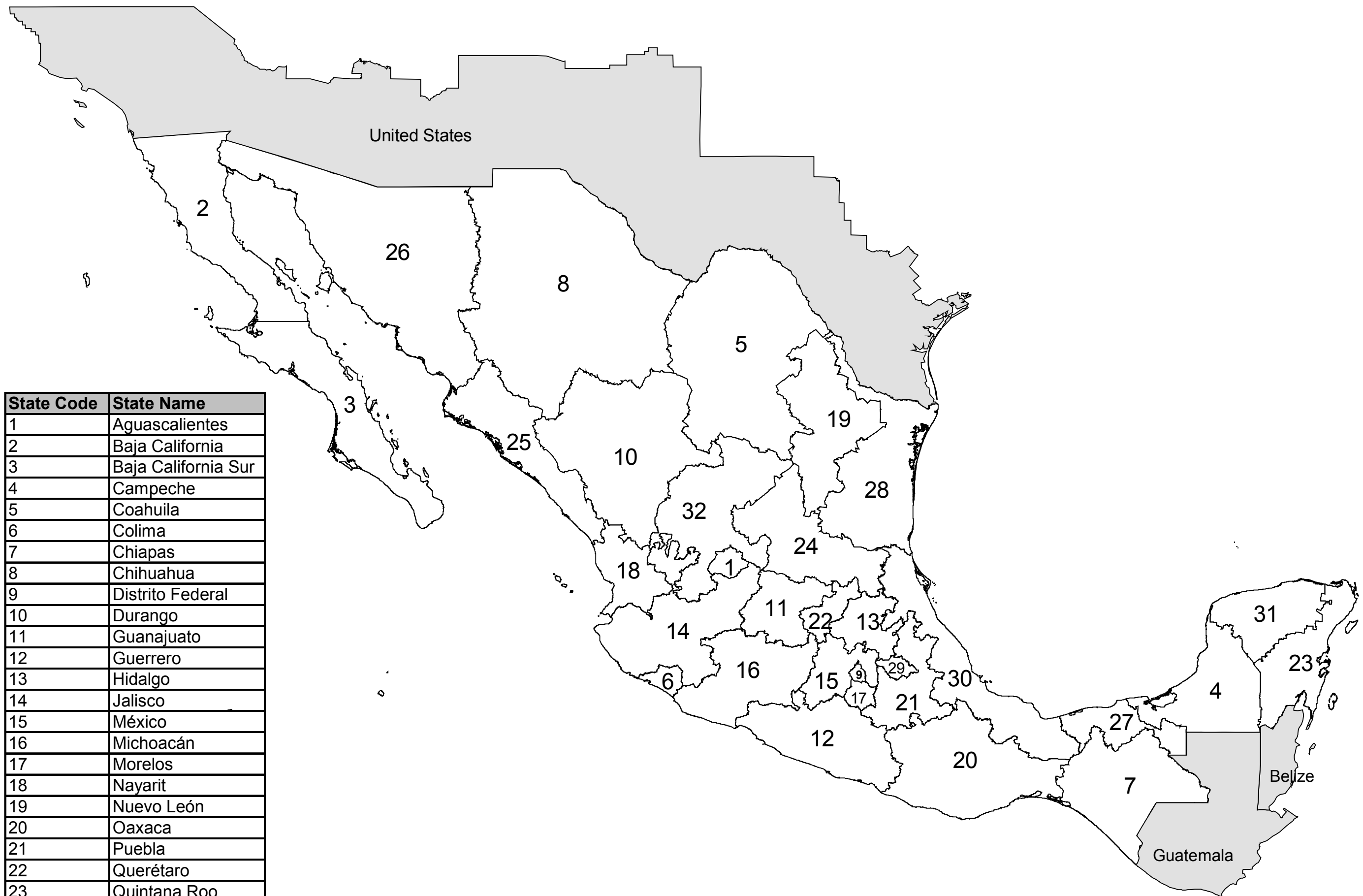
The geographic domain of the Mexico NEI is the country of Mexico. As shown in Figure 2-1, Mexico consists of 32 states including the Federal District (*Distrito Federal – DF*). Emissions for this domain have been developed in three steps:

- First, a preliminary emissions inventory for the six Mexican states that border the U.S. was developed (ERG, 2003c): Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas. These preliminary emissions were revised based on comments received, supplemented with new data, and finalized. The final emissions estimates for the six northern states are reported in this report at the state and municipality level.
- Second, an emissions inventory for all 32 Mexican states (including the DF) is being developed. This national emissions inventory, incorporating the final inventory for the six northern states, will be reported in the draft final Mexico NEI report. Emissions will be provided at the state- and municipality-level for each of the 32 states and 2,443 municipalities in Mexico.
- Third, a final emissions inventory for the entire 32 states and 2,443 municipalities will be developed, incorporating comments received on the draft final inventory.

2.1.2 Base Year and Temporal Resolution

The inventory base year of the Mexico NEI is 1999. This was believed to be a year for which most governmental agencies would possess complete sets of the types of data needed for the emissions inventory. A methodology will be developed in the future to address data and procedures for determining changes in emissions due to growth and expected controls implemented in Mexico to the year of 2018.

Figure 2-1. The Country of Mexico



State Code	State Name
1	Aguascalientes
2	Baja California
3	Baja California Sur
4	Campeche
5	Coahuila
6	Colima
7	Chiapas
8	Chihuahua
9	Distrito Federal
10	Durango
11	Guanajuato
12	Guerrero
13	Hidalgo
14	Jalisco
15	México
16	Michoacán
17	Morelos
18	Nayarit
19	Nuevo León
20	Oaxaca
21	Puebla
22	Querétaro
23	Quintana Roo
24	San Luis Potosi
25	Sinaloa
26	Sonora
27	Tabasco
28	Tamaulipas
29	Tlaxcala
30	Veracruz
31	Yucatán
32	Zacatecas

Also, the year of 1999 corresponds with U.S. EPA's triennial reporting cycle. Future enhancements to the Mexico NEI may include development of seasonal and/or daily emissions, as well as chemical speciation of pollutants as needed for input to photochemical and other atmospheric simulation models.

2.1.3 Pollutants

The Mexico NEI includes emission estimates for six pollutants: nitrogen oxides (NO_x), sulfur oxides (SO_x), volatile organic compounds (VOC), carbon monoxide (CO), particulate matter (PM), and ammonia (NH_3).

Nitrogen oxides (NO_x) are a general grouping of pollutants that includes the two primary species: nitric oxide (NO) and nitrogen dioxide (NO_2). In general, NO_x is emitted into the atmosphere by combustion sources. NO_x is an ozone precursor, but it is also an important secondary PM precursor. During the combustion process both NO and NO_2 are emitted, but NO is the primary combustion product. However, all NO_x species are typically in a rapid state of flux immediately after being emitted. The general reporting convention, which will be followed in the Mexico NEI, is that total NO_x will be reported on the basis of the molecular weight of NO_2.

Sulfur oxides (SO_x) are a general grouping of pollutants that includes many different oxide species, but the primary species is sulfur dioxide (SO_2). SO_x is emitted into the atmosphere by combustion sources due to sulfur-containing fuels (i.e., coal or fuel oil), as well various metallurgical and chemical processes that handle sulfur-containing materials (e.g., smelting, refining, sulfuric acid production, etc.). SO_x is an important secondary PM precursor. Emitted SO_2 will sometimes oxidize to sulfur trioxide (SO_3), and then to sulfuric acid (H_2SO_4) or sulfate (SO_4^{2-}) aerosols. However, the general reporting convention, which will be followed in the Mexico NEI, is that total SO_x will be reported on the basis of the molecular weight of SO_2.

Volatile organic compounds (VOC) are hydrocarbons (HC) that are typically emitted to the atmosphere by combustion sources or evaporation sources. VOC are an important precursor for ozone formation, as well as a precursor for secondary PM. VOC species are a subset of a broader group of hydrocarbons called total organic gases (TOG) which include all carbonaceous compounds except for carbonates, metallic carbides, CO, carbon dioxide (CO_2), and carbonic acid. The distinguishing feature between TOG and VOC is that VOC does not include those TOG compounds that have limited, or no, photochemical reactivity. Some previous emission inventory efforts in Mexico have been ambiguous in using hydrocarbon nomenclature (i.e., emissions have been presented as TOG, VOC, and/or HC). Although hydrocarbon emissions in the Mexico NEI are presented in terms of VOC, there is still some ambiguity in this definition depending on the source of the data on which the emissions are based. This situation is discussed as it applies to the quality of the VOC emissions estimates by source type.

Carbon monoxide (CO) is a colorless, odorless gas resulting from the incomplete combustion of fossil fuels. In urban area inventories, CO will typically be an order of magnitude larger than any other pollutant. CO is not an ozone or PM precursor, but may cause localized health effects.

There are many different ways that particulate matter (PM) can be classified. Primary PM refers to any solid, liquid, or gaseous material emitted directly from an emission source that is in solid or liquid form at ambient temperature and pressure. Secondary PM refers to aerosols that were formed from gaseous material (e.g., NO_x, SO_x, VOC, etc.) due to atmospheric chemical reactions. The Mexico NEI includes only primary PM emissions.

PM emissions are also characterized by their size. The Mexico NEI focuses on two sizes of PM: PM_{10} and $PM_{2.5}$. PM_{10} describes primary PM emissions smaller than 10 micrometers (µm) in aerodynamic diameter, while $PM_{2.5}$ describes primary PM emissions smaller than 2.5 µm in aerodynamic diameter. Many PM emission factors are in terms of PM_{10}. $PM_{2.5}$ is important because of its visibility and regional haze impacts.

Some previous emission inventory efforts in Mexico have estimated total suspended particulate (TSP) emissions. TSP is roughly defined as those primary PM emissions smaller than 30 µm in aerodynamic diameter; any particles greater than 30 µm in aerodynamic diameter will typically settle out and not stay suspended for any significant period of time. However, TSP emissions are not estimated as part of the Mexico NEI.

Ammonia emissions are included in the Mexico NEI because NH_3 typically interacts with SO_x and NO_x to form important visibility species such as ammonium sulfate ($(NH_4)_2SO_4$) and ammonium nitrate (NH_4NO_3). Ammonia is emitted from a number of different sources, but the two primary sources that are included in the Mexico NEI are livestock and fertilizer application.

2.1.4 Source Types and Categories

The Mexico NEI includes emissions for five specific types of sources including:

- Point sources – Stationary industrial facilities that are regulated by SEMARNAT or state environmental agencies. Most of these facilities emit greater than 10 megagrams (Mg) per year of total pollutants.
- Area sources – Small industrial facilities that are not classified as point sources; disperse activities such as dry cleaners, consumer solvents; and fugitive sources of particulate matter such as agricultural tilling, vehicle travel on unpaved roads, and windblown dust. Also included as area sources are locomotives, aircraft, and commercial marine vessels.
- Motor vehicle sources – Exhaust emissions from vehicles that travel on roadways, including private automobiles, taxis, buses, and heavy-duty diesel trucks.
- Nonroad mobile sources – Exhaust emissions from agricultural and construction equipment.
- Natural sources – Natural occurring emissions of VOC from vegetation, NO_x from soils, and SO_2 from volcanoes. Note that although there are no active volcanoes in the six northern states, volcanoes are significant emitters of SO_2 in other areas in Mexico.

Additional details on the specific source categories that comprise each of these source types are contained within the respective sections of this report.

2.2 Emissions Data Management

The Mexico NEI has resulted in the collection of considerable amounts of emissions and other related inventory data from dozens of public and private entities. Electronic spreadsheets were used to compile data, estimate emissions, and display results in tables and graphs. In additional, geographical information system (GIS) software was used to compile geocoded data for spatial analysis of emissions estimates.

Point source emissions were organized using several numerical systems based on source type and categories. First, emissions were compiled based on Mexico's Catalog of Activities and Products (*Catálogo Mexicano de Actividades y Productos – CMAP*) codes. Then the CMAPs were cross-referenced to determine the corresponding North American Industry Classification System (NAICS) code for each point source category. Numeric codes were not assigned to the area, motor vehicle, nonroad mobile, and natural source types/categories.

The final Mexico NEI emission inventory files will be made compatible with the U.S. EPA's National Emissions Inventory Format (NIF). In the future, database software may be used to compile and summarize the Mexico NEI data; however, development of a database is not currently part of the project scope.

2.3 Data Quality Goals

The overall quality goal for the Mexico NEI is to develop a high-quality, accurate, and comprehensive emissions inventory for the country of Mexico. Details of the quality assurance plan (QAP) are contained within the Mexico NEI Inventory Preparation Plan (ERG, 2003a). The QAP contains several specific data quality objectives (DQOs) including development of emissions estimates for all source types and all major source categories; emissions estimates at the municipality level; and emissions estimates with the best accuracy as possible based on the data available. While these are qualitative DQOs, they are appropriate for a first-time inventory for the entire country.

A confidence rating approach was used to assess the quality of individual point, area, and nonroad source category emissions estimates based upon the quality of both the activity data and emission factor(s) used to develop the estimate. These ratings, shown in Table 2-1, were adapted from an approach used by U.S. EPA when estimating national dioxin and furan emissions in the U.S. (Winters, 2002). The objective of applying this approach to each source category is to identify priorities for improving emissions estimates in the future. While other factors are also important to consider when selecting source categories or emissions data that

Table 2-1. Confidence Rating Approach

Rating	Activity Data	Emission Factor
A	Based on comprehensive Mexico-specific data	Based on comprehensive Mexico-specific data
B	Based on limited/extrapolated Mexico-specific data	Based on limited Mexico-specific data
C	Based on expert judgment	Based on expert judgment
D	Based on extrapolated U.S. data	Based on U.S. factors
E	Insufficient data	No emission factors exist

need to be improved, such as relative significance of category emissions to the overall inventory; a metric for making these decisions is the confidence of the estimate generated through the Mexico NEI process.

2.4 Factors Affecting Future Updates to the Mexico NEI

The Mexico NEI belongs to Mexico, and responsibility for maintaining and updating the inventory belongs to SEMARNAT. Thus, the future of the Mexico NEI is dependent on SEMARNAT's ability to sustain adequate technical and financial resources to conduct the work. Insofar as SEMARNAT may delegate to or partner with state and municipal environmental agencies, the amount of resources dedicated to this effort by these other agencies will impact the future of the Mexico NEI.

Another important factor will impact the quality and usefulness of the Mexico NEI in the future. Existing law and pending regulations require mandatory reporting of emissions information by industrial facilities and provide for release of that information to the public. On December 31, 2001, Article 109-bis of the LGEEPA was modified to require pollution sources to provide information to SEMARNAT (or states, municipalities, and the DF, depending on jurisdiction) for purposes of developing an inventory of emissions and transfers of pollutants to the air, water, soil and subsoil, materials and waste. This inventory is called the Pollutant Releases and Transfers Register (*Registro de Emissions y Transferencia de Contaminantes – RETC*). Article 109-bis as modified also requires that the information will be made public and accessible. The proposed mechanism for submitting these data is the Annual Operating Certificate (*Cédula de Operación Annual – COA*). The regulations implementing the COA and its submittal schedule have yet to be promulgated. The extent to which these regulations are implemented, enforced, and complied with will directly effect the level and quality of data available to update the NEI in the future.

3.0 POINT SOURCES

Point sources are stationary industrial sources that release emissions from fixed points (e.g., a stack or vent). This section defines the point source categories, describes existing emissions data for point sources in Mexico, and explains how these data were compiled, reviewed, quality checked, and corrected (as necessary) for the Mexico NEI.

The point source inventory results are presented in tabular and graphical formats to show emissions by category and pollutant for each state, and total and relative emissions by industrial category for the six northern states. Although the point source emissions inventory was compiled using emissions data for individual facilities, this report shows the emissions inventory at the source-category level due to confidentiality of the facility-level data.

3.1 Source Categories

In any emissions inventory, a key decision is the delineation between point and area sources. For the Mexico NEI, a decision was made to classify industrial point sources based upon the jurisdiction under which the facility operates. For the Mexico NEI, point sources include those industrial facilities under federal or state jurisdiction.

Federal jurisdiction point source categories include industrial facilities in the following 11 sectors, plus industrial facilities that are located with "federal zones" (regardless of sector):

<table>
<tr><td>Petroleum extraction and petroleum/petrochemical manufacturing</td><td>Electrical energy generation</td></tr>
<tr><td>Chemical manufacturing</td><td>Hazardous waste treatment</td></tr>
<tr><td>Paints and inks manufacturing</td><td rowspan="7">Facilities located within federal zones:
• Federal airports, train and bus stations, ports, and transportation systems
• Industrial parks located on federal land
• Within 25 kilometers (km) of any coastline
• If impacting other states or countries
• Within Mexico City metropolitan area</td></tr>
<tr><td>Metal products manufacturing</td></tr>
<tr><td>Automotive parts manufacturing</td></tr>
<tr><td>Pulp and paper manufacturing</td></tr>
<tr><td>Cement and lime manufacturing</td></tr>
<tr><td>Asbestos mining and manufacturing</td></tr>
<tr><td>Glass manufacturing</td></tr>
</table>

State jurisdiction point sources are industrial facilities not included within the 11 federal sectors and not located within a federal zone. Generally, industrial facilities under state jurisdiction include operations that a state requires to obtain and update an operating permit. The types of industries required to obtain permits are determined at the discretion of the state environmental agency (SEA); therefore, the categories considered to be point sources may vary between states. For the Mexico NEI, all facilities under federal or state jurisdiction were considered to be point sources.

It is possible that some industrial source emissions are inadvertently included within both the point and area source types. This is mainly an issue for fuel combustion emissions from smaller industrial facilities when the fuel combustion emissions may be counted as a point source as well as within the industrial fuel combustion (area source) category. To avoid double counting of emissions, a correction was made to the fuel consumption quantities reported for area sources by subtracting the quantity of fuel combusted by point sources. This "reconciliation" was made for four fuels: distillate, residual, natural gas, and liquefied petroleum gas (LPG). (Additional details on the point/area source reconciliation are provided in Section 4.2.3 of this report.)

3.2 Methodology

The point source inventory was based upon existing emissions data provided by SEMARNAT, the SEAs, and other governmental agencies such as SENER. Details of the data collection, data review, and quality assurance (QA) activities used to develop the point source inventory are described below.

3.2.1 Data Collection

The four sets of existing emissions data that were identified for federal and state jurisdiction point sources are described below.

Federal COAs

Federal COAs are emission reports from federal point sources that were submitted directly to INE or via SEMARNAT delegations located in each state for years 1999 or 2000.

COAs collect the following types of information relevant to Mexico NEI development, although the COAs are inconsistent with regard to their completeness pertaining to this information:

- General information (e.g., facility name, CMAP code, municipality, address);
- Emission releases (e.g., Mg/year of criteria pollutants, carbon dioxide);
- Raw materials (e.g., Chemical Abstract Service [CAS] number, chemical name, usage in Mg/year);
- Products (i.e., product name, production level);
- Fuel usage (i.e., type of fuel, yearly usage);
- Energy consumption (i.e., yearly consumption of electricity);
- Equipment (e.g., type, hours of operation, capacity, fuel type and consumption);
- Stack parameters (i.e., type, size, gas velocity, temperature); and
- Pollutants (e.g., applicable standard, allowable and actual emissions, monitoring method).

Some of these federal COAs had been entered into a spreadsheet, while others were stored in paper format. Although submittal of COAs by industries has been mandatory since 1997, submittal of air emissions data for RETC remains voluntary. It is expected that RETC data submittal related to air emissions will become mandatory during second half of 2004.

State COAs

State COAs are emission reports from state point sources that were submitted to the SEAs for 1999 or 2000. Questionnaires were sent to each SEA to determine the number of facilities reporting in each state, and the year, type, and format of the data collected. Some of these COAs had been entered into a spreadsheet, but most were stored in paper format.

National Power Plant Inventory for 1999

A national power plant inventory for 1999 was provided by SENER for the Mexico NEI (SENER, 2003). The types of information provided as part of this inventory included the following:

- Name of plant and 3-letter code;
- Type of plant (e.g., thermoelectric, carboelectric);
- Quantity and fuel type (e.g., million cubic meters [10^6 m^3] per year of natural gas);
- Fuel sulfur content, if applicable;
- Plant generation in gigawatt-hours (GW-hr); and
- Emissions by plant, region, and overall type (e.g., CO, NO_x, nonmethane organic compounds [NMOC], SO_2, TSP).

The information in SENER's inventory was used for all power plants in the Mexico NEI in place of power plant COAs or *Datos Generales* (DATGEN) emissions information.

DATGEN

DATGEN is a spreadsheet containing emissions inventory information for federal and state point sources (mainly combustion emissions), located in areas where air quality plans have already been developed. DATGEN (stands for "Datos Generales") is updated every two years; the next update will be issued in 2003 with data collected during 2001-2002. The areas and the year for their emissions inventory contained in the current DATGEN are as follows:

- Mexico City Metropolitan Area and Valley of Mexico, DF and the State of Mexico, (preliminary for 2000);
- Guadalajara, Jalisco (1995);
- Metropolitan Zone of Monterrey, Nuevo León (1995);
- Tijuana and Rosarito, Baja California (1998);
- Ciudad Juárez, Chihuahua (1996);
- Valley of Toluca, Mexico (preliminary 2000);
- Mexicali, Baja California (1996); and
- La Laguna (i.e., Torreón, Coahuila; and Lerdo and Gómez Palacios, Durango) (2002).

Multiple worksheets collect the following information for the facilities located in these areas. These worksheets are described below:

- Worksheet #1: Facility name, fuel type and usage, emissions (mainly NO_x and SO_2 emissions; some CO, VOC, and PM emissions) in Mg/year;
- Worksheet #2: Facility name, location (latitude and longitude), quantity of raw material processed, quantity of materials manufactured or produced, fuel type and usage; and
- Worksheet #3: Summary of selected information that is contained on other worksheets plus stack parameters (e.g., type, height, temperature, flow rate). (Although these data are available in DATGEN, they were not provided in the version used to develop the Mexico NEI due to facility confidentiality concerns.)

Most of the DATGEN data were for years prior to 1999, and most facilities in DATGEN were also accounted for in the federal and state COAs. However, because the COAs for Baja California state jurisdiction point sources are not available , the DATGEN data for the municipalities of Mexicali (1996) and Tijuana/Rosarito (1998) were used. As a result, the point source emissions for Baja California are outdated (for years previous to 1999) and are likely underestimated (since only two municipalities are accounted for). If 1999 emissions for the state jurisdiction point sources in Baja California are available in the future, then the DATGEN data will likely be replaced with the state-level data for these sources.

No NH_3 emissions were estimated for point sources since the COAs did not contain estimates of this pollutant, and activity data contained in the COAs were largely inadequate to independently estimate these emissions. Ammonia emissions from point sources may be added to the next version of the Mexico NEI.

3.2.2 Quality Assurance

The federal COAs contained in spreadsheets and the DATGEN data were reviewed to determine the number of facilities and the types of emissions (e.g., combustion, process-related) in each group. A general QA review checked for out-of-range (i.e., extremely high or extremely low emissions, etc.) and duplicate records. Emissions for a few facilities were determined to be clearly out-of-range; however, some excessive emissions for a few other sources could not be determined with certainty to be out-of-range, so these emissions were left in the data set and subjected to additional QA. If DATGEN and COA data were found for the same source, then the DATGEN data were dropped and COA data were maintained.

An analysis of the overall DATGEN and federal COA emissions data (for a total of 996 facilities) showed that most of the emissions (>90 percent of the total emissions of all pollutants) were emitted by a small number of facilities (<20 percent of the total facilities), and that those facilities generally emitted greater than10 Mg/year of total pollutants. Based on this finding, it was decided to focus resources on facilities/COAs emitting 10 Mg/year or more. Combustion emissions for the facilities emitting less than 10 Mg/year were assumed to be included within the industrial fuel combustion area source categories. However, it should be noted that this decision increases the uncertainty in the overall point source emissions inventory due to the exclusion of many facilities. This is compounded by the problem that many facilities did not submit COAs for 1999 and/or did not report air emissions since reporting air emissions via the RETC program was not mandatory for 1999. Based upon questionnaires returned by the SEAs, work was conducted in some states to load their COAs into spreadsheets while focusing on sources emitting 10 Mg/year or more. Also, federal COAs (potentially emitting 10 Mg/year or more) in paper format were entered into spreadsheets. At this point, the emissions inventory information for all sources emitting 10 Mg/year or more contained in the federal COAs, the state COAs, and DATGEN, along with SENER emissions data for all the power plants, were combined into the Mexico NEI point source database containing emissions data for 556 facilities within the six northern states.

A detailed QA review of approximately 320 COAs (of the 556 compiled to that point) was conducted according to the QA Plan contained in the Mexico NEI Inventory Preparation Plan (ERG, 2003a). These COAs were selected according to two criteria: (a) the largest emitters were checked; and, (b) between 10 and 20 percent of the remaining facilities (selected randomly) were checked. Examples of the detailed QA checks, along with corrective actions that were performed, included the following:

- Can emissions be verified (e.g., are equipment and/or production data provided)? If not, then emissions were included “as is”.
- Are correct emission factors used? If not, then the correct emission factor was used and the emissions were recalculated.

- Are all pollutants estimated for combustion sources (i.e., NO_x, SO_x, CO)? If not, then the best emission factor(s) was used and the emissions for the missing pollutants were calculated, if possible. If the missing emissions could not be determined (e.g., activity data were missing), then a comment was made in the spreadsheet.

- Are VOC emissions reported as TOG, total organic compounds (TOC), or HC? If so, then it was assumed that all these emissions were VOC.

- If TSP is reported, are the emissions for PM_{10} and $PM_{2.5}$ reported as applicable? If not, then the TSP (or PM_{10}) emissions were determined using the California Air Resources Board PM Size Fraction Table (ARB, 2002).

When a facility's emissions could not be verified, or if corrections were made, comments were placed in the appropriate state's spreadsheet. The following observations were made regarding the number and types of QA actions taken on the 320 facility COAs checked:

- 140 could not be verified;

- 24 were verified as correct and not changed; and

- 156 were corrected, including 29 that were determined to emit less than 10 Mg/year.

After the Mexico NEI point source database was compiled, it was reviewed to make sure that no potentially significant point sources were omitted. This was done by checking the facilities in the compiled point source database against information on the *Petróleos Mexicanos* (PEMEX) website (www.pemex.gob.mx) and relevant government and trade association publications for certain federal industrial sectors such as mining, fuel distribution facilities, and cement and lime manufacturing. These publications contain information such as facility name, type, location, and production data (INEGI, 1999a; INEGI, 2000a; SECOFI, 1999; CNIME, 2000; Acosta y Asociados, 2001). As a result, 18 additional facilities located within the six northern states were identified; emissions for 8 facilities were added to, and 4 were corrected in, the point source database for the Mexico NEI (6 were already in the database, but under a different name). This brought the total number of facilities in the point source database to 564.

A final QA review occurred after the preliminary point source inventory was published (i.e., July 2003). This review, which was conducted by a large number of Mexican and

U.S. state and federal agencies, industries, and stakeholders, resulted in some modifications to the preliminary point source inventory. The modifications included the following:

- Emissions for five facilities were corrected (previously "out-of-range") using new emission factors developed from data obtained from COAs of different years (other than 1999);
- Emissions for the Cadereyta refinery (in Nuevo León) were added and emissions for the Madero refinery were (in Tamaulipas) modified based on data provided by PEMEX (PEMEX, 2003a);
- Emissions for five medical waste incinerators were added based on data from COAs; and
- Emissions for a battery manufacturing plant in Baja California and a cement plant in Coahuila were deleted because they had been duplicated.

These changes brought the total number of facilities in the point source database for the six northern states to 568. It should be noted that this number of sources is much less than the actual number of point sources operating in the six northern states (i.e., 966 facilities were represented in the original data set compiled from DATGEN, COAs, the SEAs and SENER). This is due to the way these are defined for the Mexico NEI (i.e., facilities under federal and state jurisdiction that emit 10 Mg/year). Although these facilities do not comprise the entire point source population in the six northern states, they do account for the majority of point source emissions.

3.3 Results by Source Category

The results of the final 1999 point source emissions inventory for the six northern Mexican states are shown in Tables 3-1 and 3-2, and Figures 3-1 through 3-6. Appendix B contains additional tables that show emissions by source category (i.e., NAICS code) for each state.

As shown in Table 3-1, final 1999 annual emissions from point sources in the six northern Mexican states are estimated to be approximately 185,000 Mg for NO_x, 638,000 Mg for SO_x, 68,000 Mg for VOC, and 66,000 Mg for CO. This NO_x/VOC ratio of 2.7 (and which is normally in the range of 1 to 2 in a typical emissions inventory) indicates potentially underestimated VOC emissions, which is consistent with findings during the COA review and

Table 3-1. 1999 Point Source Emissions for Mexico, by State Six Northern Mexican States (Final)

State Name	Annual Emissions (Mg/year)					
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Aguascalientes						
Baja California	5,695.4	26,605.1	16,567.3	757.8	4,697.4	3,849.7
Baja California Sur						
Campeche						
Coahuila	113,102.6	157,748.2	921.6	15,974.4	19,732.7	18,940.5
Colima						
Chiapas						
Chihuahua	18,133.2	65,187.6	2,308.3	13,821.6	7,241.3	6,278.6
Distrito Federal						
Durango						
Guanajuato						
Guerrero						
Hidalgo						
Jalísco						
México						
Michoacán						
Morelos						
Nayarit						
Nuevo León	20,563.7	82,031.7	20,680.5	22,114.5	10,651.2	9,422.3
Oaxaca						
Puebla						
Querétaro						
Quintana Roo						
San Luis Potosí						
Sinaloa						
Sonora	12,964.2	157,276.7	1,617.3	3,146.8	30,880.6	14,737.2
Tabasco						
Tamaulipas	14,756.6	148,757.9	26,215.7	10,654.7	4,770.2	3,597.4
Tlaxcala						
Veracruz						
Yucatan						
Zacatecas						
Border States	**185,215.9**	**637,607.2**	**68,310.5**	**66,469.8**	**77,973.4**	**56,825.7**
National						

Table 3-2. 1999 Point Source Emissions for Mexico, by Category
Six Northern Mexican States (Final)

Point Source Categories	No. of Facilities	Annual Emissions (Mg/year)					
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Apparel Manufacturing	5	1,077.4	0.1	294.7	1,803.0		
Beverage & Tobacco Product Manufacturing	7	201.6	905.7	1.5	16.9	112.0	81.6
Chemical Manufacturing	78	5,239.3	7,446.8	2,231.6	4,101.3	3,993.6	3,684.8
Computer & Electronic Product Manufacturing	47	153.0	4.2	2,350.7	118.5	245.3	212.7
Electrical Equipment, Appliance & Component Manufacturing	37	247.6	4.4	1,247.3	1,210.3	3,462.4	3,199.1
Fabricated Metal Product Manufacturing	40	2,713.4	164.4	2,229.5	441.7	4,672.7	4,188.0
Food Manufacturing	33	1,444.1	3,028.7	117.1	1,772.4	285.0	166.4
Furniture & Related Product Manufacturing	13	1.2	1.3	887.0	0.3	0.1	0.1
Machinery Manufacturing	13	38.2	0.1	240.6	27.4	30.3	28.2
Merchant Wholesalers, Nondurable Goods	13		1.1	2,027.9	95.0		
Mining (except oil & gas)	34	1,763.9	6,890.5	72.9	8,387.3	21,218.2	6,345.3
Miscellaneous Manufacturing	34	86.8	0.9	927.1	50.6	59.9	45.4
Nonmetallic Mineral Product Manufacturing	40	10,428.1	20,798.4	1,386.8	7,694.4	2,095.4	1,644.0
Other Manufacturing	6	24.5	98.1	110.7	106.5	9.7	7.6
Paper Manufacturing	22	705.0	5,728.2	711.0	6,766.8	1,731.6	1,318.3
Petroleum & Coal Product Manufacturing	4	8,266.2	71,728.0	42,802.9	14,955.3	4,459.8	2,902.8
Plastics & Rubber Product Manufacturing	10	1,407.6	503.2	200.9	290.3	47.2	43.7
Primary Metal Manufacturing	26	7,497.7	20,225.6	252.3	8,550.2	10,513.9	8,440.8
Transportation Equipment Manufacturing	40	374.6	13.6	8,469.3	404.3	604.5	513.5
Utilities	35	143,459.8	500,010.1	1,123.4	9,082.3	24,365.9	23,938.8
Waste Management & Remediation Services	7	53.8	0.1	18.4	0.4	30.0	29.9
Wood Product Manufacturing	24	32.1	53.7	606.9	594.6	35.3	34.3
Total from Point Sources	**568**	**185,215.9**	**637,607.2**	**68,310.5**	**66,469.8**	**77,973.4**	**56,825.7**

**Figure 3-1. 1999 NO_x Emissions for Mexico: Point Sources
Six Northern Mexican States (Final)**

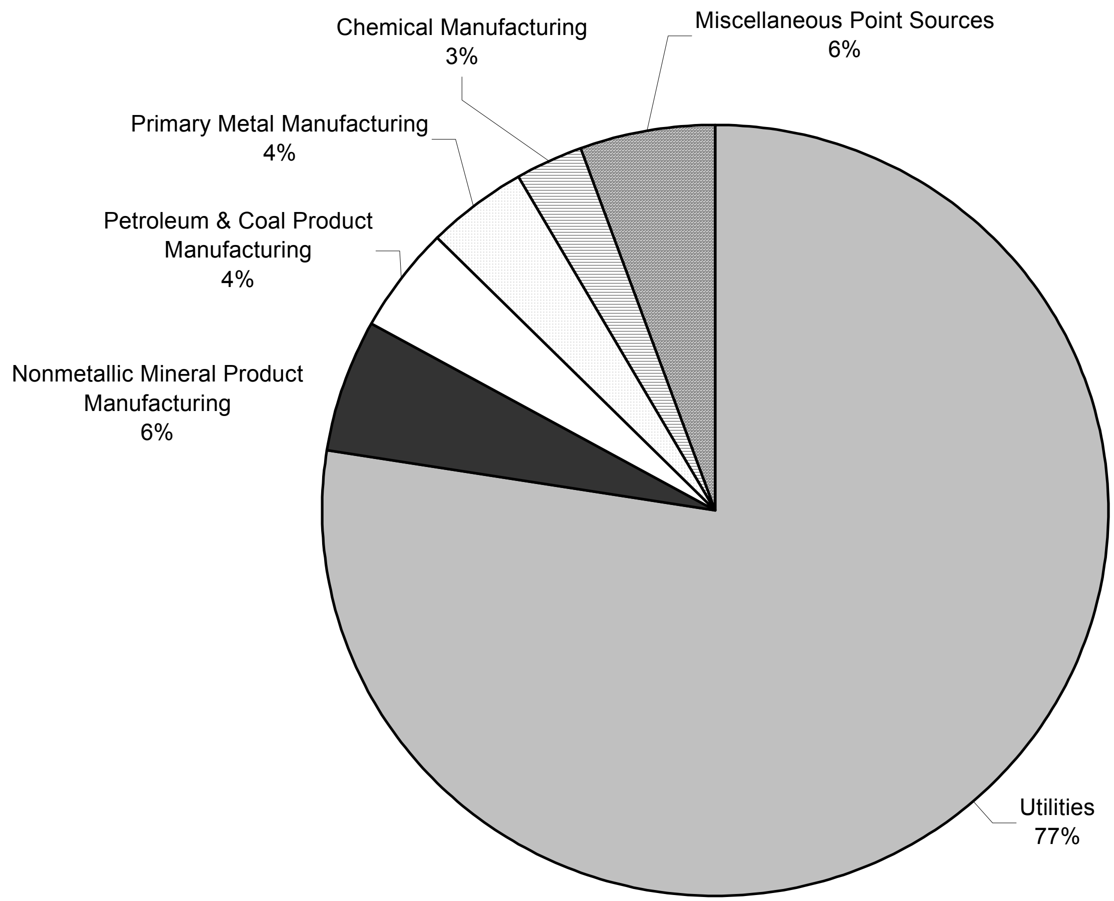


**Figure 3-2. 1999 SO_x Emissions for Mexico: Point Sources
Six Northern Mexican States (Final)**

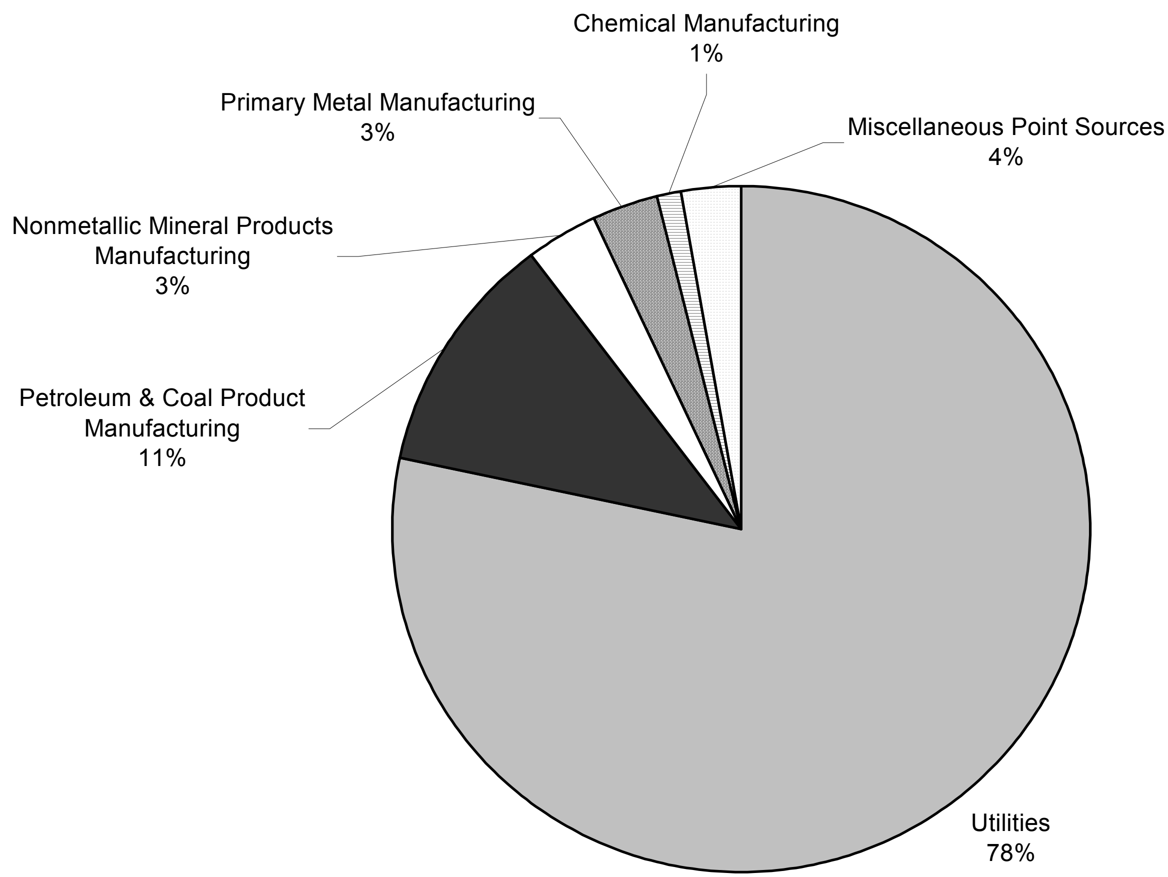


**Figure 3-3. 1999 VOC Emissions for Mexico: Point Sources
Six Northern Mexican States (Final)**

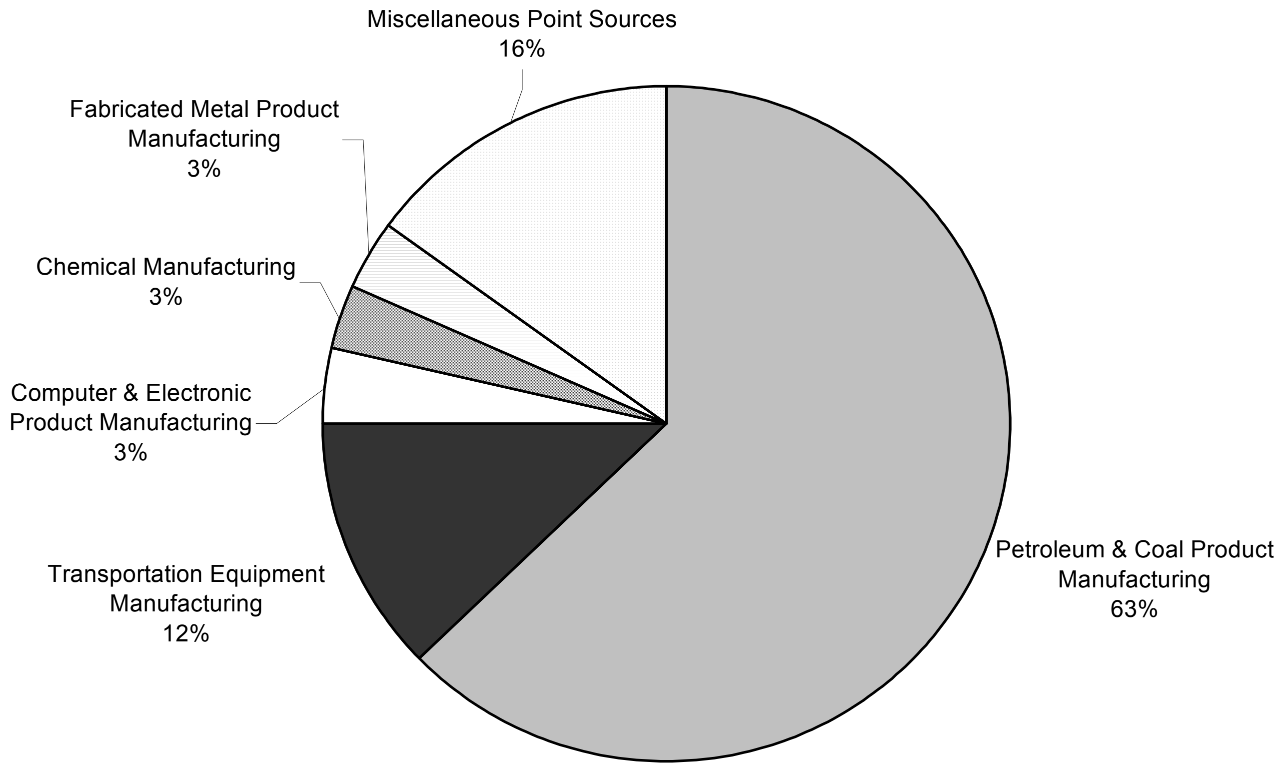


Figure 3-4. 1999 CO Emissions for Mexico: Point Sources
Six Northern Mexican States (Final)

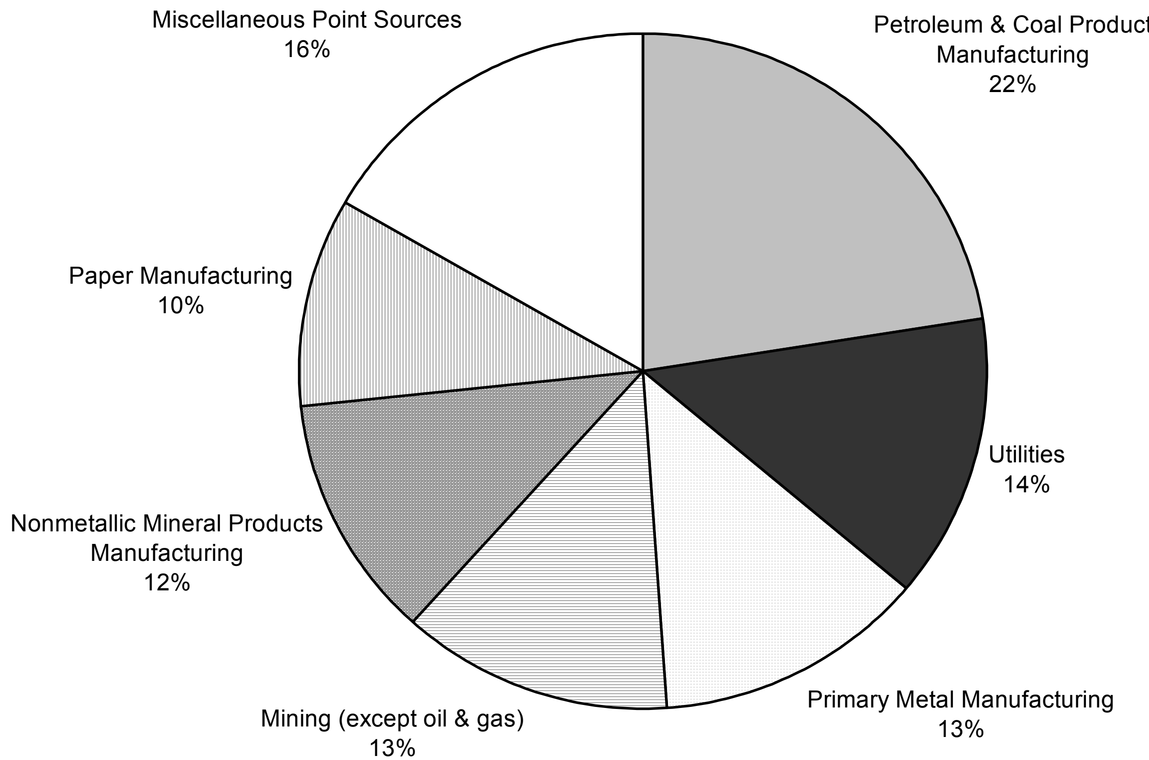


Figure 3-5. 1999 PM_{10} Emissions for Mexico: Point Sources
Six Northern Mexican States (Final)

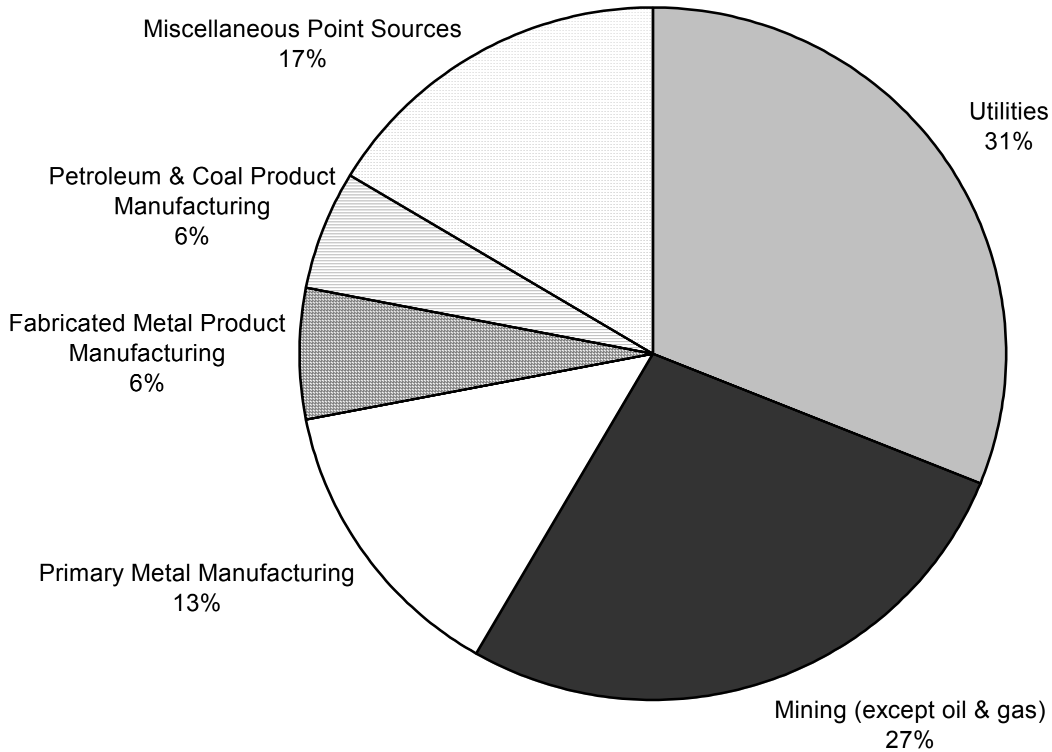
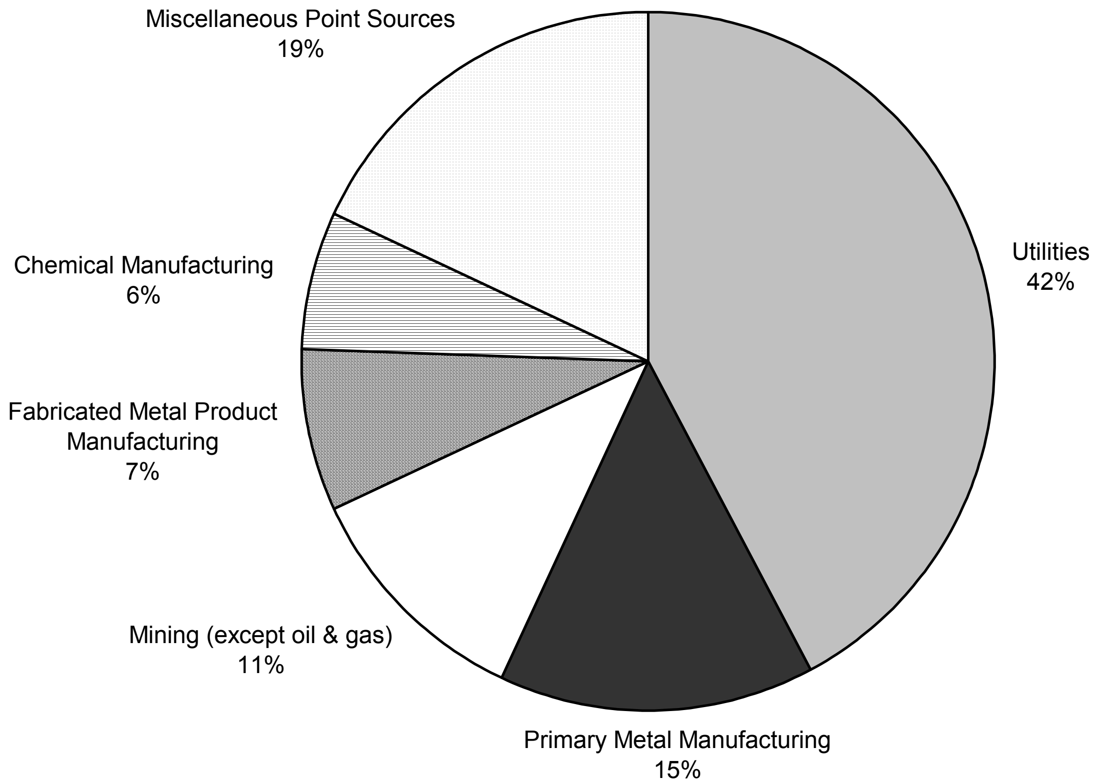


**Figure 3-6. 1999 $PM_{2.5}$ Emissions for Mexico: Point Sources
Six Northern Mexican States (Final)**



QA process. The CO/NO_x ratio of 0.359 is reasonable considering the significant impact on the total NO_x and CO emissions by the two coal-fired power plants in Coahuila (e.g., the CO/NO_x ratio for most pulverized coal emission factors is 0.3).

Also, Table 3-1 shows that Coahuila has the most emissions of NO_x (contributed mainly by power plants). Power plants in Coahuila, Sonora, and Tamaulipas also emit most of the SO_x emissions from point sources in those states. Nuevo León has the most CO emissions (mainly from a PEMEX refinery and a steel manufacturing plant), and Baja California has the most VOC emissions (mostly from operations involving painting and use of solvent). In summary, it is important to note that the emissions for Baja California are likely underestimated for most pollutants since only two municipalities were included in the DATGEN data for this state); however, Baja California emissions of NO_x and SO_x from power plants and PEMEX plants account for more than 80 percent of total emissions of each of these two pollutants, and these estimates are believed to be very accurate.

Table 3-2 shows the point source emissions inventory for 1999 by source category, based on NAICS codes, for the six northern Mexican states. State jurisdiction facilities within categories comprising emissions from fewer than three facilities were aggregated into the "other manufacturing" category. (Current laws allow disclosure of emissions from facilities under federal jurisdiction, or when the emissions data is provided by the federal government on behalf of the states; however, there are no such disclosure laws relevant to state jurisdiction point sources when the data were provided directly by the state.) This table shows the significant contribution to the overall inventory (all pollutants) by the utilities, petroleum and coal products, nonmetallic mineral products, primary metal manufacturing, and mining industries.

Again, it should be noted that the point sources in this inventory are limited to facilities that emit 10 Mg/year or more based on DATGEN, 1999 COAs, and data provided directly by the SEAs, SENER, and PEMEX. Therefore, these point sources do not comprise the entire point source population in the six northern Mexican states, although they do account for the majority of point source emissions.

Findings are also shown in terms of relative contribution in Figures 3-1 through 3-6, by pollutant. The following observations can be made regarding the results shown on these figures:

- NO_x emissions are mainly from utilities (thermoelectric and carboelectric plants);
- SO_x emissions are mainly from utilities;
- The main sources of VOC emissions are PEMEX refineries (petroleum and coal product manufacturing);
- The main sources of CO emissions are PEMEX refineries, utilities, primary metal manufacturing, mining, nonmetallic mineral product manufacturing, and paper manufacturing;
- Utilities, mining, and primary metal manufacturing are the three most significant sources of PM_{10} and $PM_{2.5}$ emissions.

3.3.1 Confidence Ratings

The confidence rating approach (as described in Section 2.3 of this report) was applied to each facility that was subject to a detailed QA check, including all power plants. The rating of the facility's activity data and emission factor (or other method used on the COA, such as direct measurement) was assessed, and then an overall rating for each facility was determined based on the lowest rating for either activity data or emission factor.

The activity data confidence ratings ranged from A to E. Most activity data ratings were either B (indicative of the use of Mexico-specific data for fuel combustion for most sources), or E (when data could not be verified). Activity data for all power plants were rated A to reflect the high confidence of SENER's inventory including the use of Mexico- and plant-specific data for fuel combustion. Also, emissions estimates for refineries as provided by PEMEX were rated A to reflect the source-specific data used by PEMEX to estimate emissions.

The emission factor confidence ratings also ranged from A to E. Most emission factors were rated either A (for all power plants), B, or C (mainly for emissions that were revised through the QA process using data from direct measurements or other data provided on the COA).

Overall ratings of emissions for facilities that were missing from the existing databases (i.e., COAs and DATGEN) but were found through the QA process and estimated using extrapolation techniques were rated D or E. Overall ratings for facilities that could not be verified (CNBV) were rated E. Although the overall ratings ranged from A to E, emissions for approximately 50% of facilities were rated E. Overall confidence ratings of emissions for all facilities emitting more than 1,000 Mg/year showed that most emissions were rated either A (power plants), E (including those facilities with emission values considered out-of-range), or were not rated since they were not reviewed as part of the QA process.

The overall quality of the point source inventory should improve with future versions of the NEI because of changes that SEMARNAT has initiated with regard to COA format and submittals. For example, SEMARNAT has changed the COA form to improve reporting of emissions data, is in the process of developing a reporting software, and has provided written instructions to facilities. All of these changes should help facilities to provide more accurate and comprehensive COA data in the future.

An additional action that will further improve the COAs specifically for purposes of the NEI is to develop a list of "minimum requirements" that SEMARNAT staff will use during COA review and prior to data entry (e.g., fuel type and usage; process type and raw material usage; stack parameters; latitude and longitude). If the minimum requirements are not provided on the COA as submitted by the facility, then SEMARNAT staff would contact the facility to provide the missing information. If the minimum requirements are still not provided by the facility, then the COA would be found incomplete and the facility would be out of compliance with the mandatory COA submittal regulation.

4.0 AREA SOURCES

Area sources are primarily sources that are too numerous and dispersed to be effectively included in the point source inventory. This section defines the area source categories, describes the methods used, and explains how the data used to estimate area source emissions were compiled, reviewed, and quality checked for the Mexico NEI. The area source inventory results are presented in tabular and graphical formats to show emissions by category and pollutant for each state, and total and relative emissions by category and pollutant for the six northern states.

4.1 Source Categories

As explained in Section 3.0, the delineation between industrial point sources and industrial area sources in the Mexico NEI is based upon jurisdiction. For purposes of the Mexico NEI, area sources are defined as all stationary sources, except for federal and state jurisdiction point sources that emit 10 Mg/year or more, and include the following source categories:

Fuel combustion: industrial, commercial, residential, agricultural, and transportation	Nonroad sources: locomotives, commercial marine vessels, and aircraft
Border crossings	Charbroiling and street vendors
Bus and truck terminals	Pesticide application
Consumer solvent use	Fertilizer application
Surface coating: industrial and architectural	Beef cattle feedlots
Autobody refinishing	Agricultural burning
Degreasing	Livestock ammonia
Dry cleaning	Agricultural tilling
Graphic arts	Open burning: waste
Traffic markings	Wastewater treatment
Asphalt application	Landfills
Gasoline distribution	Wildfires
Liquefied petroleum gas (LPG) distribution	Structure fires
Bakeries	Road dust: paved and unpaved roads
Brick kilns	Wind erosion
Construction activities	Domestic ammonia

Emissions were estimated for all of these categories, except for three:

- Bus and truck terminals;
- Landfills;
- Wind erosion.

The emission methodologies for bus and truck terminals and landfills require local activity data (e.g., number of vehicles entering and exiting terminals, vehicle idling times, landfill capacity, landfill age, etc.). However, because these types of local activity data are unavailable at the national, state, and municipality levels, emissions from bus and truck terminals, and landfills could not be estimated with an acceptable level of confidence for the Mexico NEI. Mexico wind erosion emissions for 1996 were previously estimated as part of the development of a new wind erosion model for the Western Regional Air Partnership (WRAP) (Mansell et al., 2003; ENVIRON et al., 2004). This wind erosion model is based upon wind tunnel studies conducted on various land types throughout the U.S. and is believed to be a more accurate methodology than any other currently existing methodologies. However, the available Mexico land-use and land-cover data used to develop the 1996 emission estimates had considerably less detail than what was used for the U.S. As a result, the emission estimates for Mexico have a fairly high level of uncertainty. In addition, the 1996 emission estimates were only developed for a portion of Mexico. Finally, because wind erosion emissions are a function of time-specific meteorological conditions (i.e., wind speed), it is not appropriate to use the 1996 emission estimates for the 1999 Mexico NEI. For these reasons, it was decided not to include wind erosion estimates in this version of the Mexico NEI. The WRAP model is currently undergoing additional revisions. Following the completion of these model revisions, it may be appropriate to use the model in future versions of the Mexico NEI.

4.2 Methodology

For most area source categories, emissions were calculated using activity data and an emission factor that relates the quantity of a pollutant released to a unit of activity. Most of the emission factors used to estimate area source emissions came from the following sources of information:

- The Mexico Emission Inventory Program Manuals;
- The Emission Inventory Improvement Program (EIIP) documents;
- U.S. EPA's *Compilation of Air Pollutant Emission Factors (AP-42)*; and

- Special studies conducted in the U.S. and Mexico for specific sources such as charbroiling, brick manufacturing, waste disposal, agricultural tilling, and paved and unpaved road dust.

Specific references for emission factors and activity data, as well as details on methods, assumptions and sample calculations are provided in the area source category forms located in Appendix C.

4.2.1 Data Collection

An extensive data collection effort was carried out for the Mexico NEI. Using the Area Source Matrix provided in the Mexico NEI Inventory Preparation Plan (ERG, 2003a), a list of data needs was developed. Through meetings, teleconferences, and other means the following organizations were contacted to provide the data needed for the area source categories:

- National Association of Paint and Dye Manufacturers (*Asociación Nacional de Fabricantes de Pinturas y Tintas – ANAFAPYT*);
- National Chamber of the Dry Cleaning Industry (*Cámara Nacional de la Industria de Lavanderías – CANALAVA*);
- National Chamber of the Manufacturing Industry *(Cámara Nacional de la Industria de la Transformación – CANACINTRA*);
- National Chamber of the Cosmetics and Perfume Industry (*Cámara Nacional de la Industria de Perfumería y Cosmética – CANIPEC*);
- Interagency Commission for Control of Pesticides, Fertilizers, and Toxic Substances (*Comisión Intersecretarial para el Control del Proceso y Uso de los Plaguicidas, Fertilizantes y Substancias Tóxicas – CICOPLAFEST*);
- INE;
- National Institute of Statistics, Geography, and Computing (*Instituto Nacional de Estadística, Geográfica e Informática – INEGI*);
- Mexican Oil Company (*Petróleos Mexicanos – PEMEX*);
- Secretariat of Agriculture, Livestock, Rural Development, Fisheries, and Food (*Secretaría de Agricultura, Ganadería y Desarrollo Rural, Pesca y Alimentación – SAGARPA*);
- Secretariat of Energy (*Secretaría de Energía – SENER*); and

- National Autonomous University of Mexico (*Universidad Nacional Autónoma de México – UNAM*).

Spreadsheets were developed to calculate emissions by source category using the best available methods and the data obtained from the organizations and technical sources listed above.

4.2.2 Fuels Balance

A special task was conducted to help develop data needed to estimate emissions for the fuel combustion category. First, energy balance and fuel sales statistics were obtained from SENER and PEMEX. These data were then compiled on a fuel-specific basis. Petroleum liquid sales data were obtained at the bulk terminal level (PEMEX, 2003b). LPG sales data were obtained at the distribution plant level, while natural gas sales data were obtained at the regional level (PEMEX, 2003c). State- and municipality-level data were then developed to support the emission estimates in this inventory. Details on the method and results of the national fuels balance on provided in a technical memorandum located in Appendix A of this report.

4.2.3 Area/Point Source Reconciliation

As mentioned in Section 3.0, the area source inventory was reconciled with the industrial point source inventory to avoid double-counting of point source emissions within various area source fuel combustion categories. The reconciliation was limited to the most significant types of fuel combustion (i.e., distillate, residual, natural gas, and LPG) used in industrial facilities; reconciliation of industrial surface coating and solvent use was not conducted due limited point source information for these categories. The reconciliation of area source fuel combustion was conducted by subtracting the reported state-level point source fuel use from the estimated state-level industrial area source fuel use. In some cases (i.e., residual fuel in Sonora and Tamaulipas, natural gas in Nuevo León, and LPG in Baja California and Coahuila), the reported state-level point source fuel use exceeded the estimated state-level industrial area source fuel use. These cases, which are not uncommon in regional inventories based on a variety of data sources such as the Mexico NEI, may be the result of uncertainty associated with the allocation of national-level data to the state-level. In these cases, the state-level industrial area source fuel use was set to zero.

4.2.4 Quality Assurance

Quality assurance reviews were conducted throughout the development of the area source inventory according to the QA Plan contained in the Mexico NEI Inventory Preparation Plan (ERG, 2003a). Specific QA checks were as follows:

- Accuracy checks of 100 percent of the equations used in the spreadsheets to calculate emissions. Also, 50 percent of the calculations were checked by hand.
- Completeness checks of the categories and pollutants from the spreadsheets were compared to the Area Source Matrix (ERG, 2003a) to ensure that emissions were estimated for the correct categories and pollutants.
- Reviews of the emission factors and activity data used to estimate emissions were performed to ensure they were representative and appropriate for each source category. All adjustment factors (e.g., used to allocate national activity to a state or municipality) were reviewed to ensure they were representative of conditions in 1999.

All errors discovered during the QA review were corrected.

4.3 Results by Source Category

Emissions in Mg/year for each source category, by state and pollutant, are provided on the source category forms located in Appendix C. The overall results of the area source emissions inventory for the six northern Mexican states in 1999 are shown in Tables 4-1 and 4-2, and Figures 4-1 through 4-7.

Table 4-1 shows that for most pollutants the states of Baja California, Chihuahua, and Nuevo León have the greatest amount of area source emissions. This is somewhat expected because these three states have the largest metropolitan areas in the six border states (i.e., Monterrey, Ciudad Juárez, Tijuana, and Mexicali), as well as a higher level of industrialization. One exception is CO, where the greatest amount of area source (fuel combustion) emissions are in the State of Sonora. Another exception is NH_3, where the greatest amount of area source emissions are in the states of Sonora, Chihuahua, and Tamaulipas. The NH_3 emissions are primarily from livestock ammonia and fertilizer application which is not surprising considering the large amount of rural areas in these three states.

Table 4-1. 1999 Area Source Emissions for Mexico, by State
Six Northern Mexican States (Final)

State Name	Annual Emissions (Mg/year)						
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Aguascalientes							
Baja California	12,481.3	14,096.9	51,289.0	33,333.6	113,096.3	22,715.3	10,118.5
Baja California Sur							
Campeche							
Coahuila	8,412.0	7,387.7	46,868.6	20,402.7	89,327.4	17,983.3	26,707.9
Colima							
Chiapas							
Chihuahua	14,082.2	21,146.6	68,085.0	52,393.4	147,318.1	30,757.3	41,728.8
Distrito Federal							
Durango							
Guanajuato							
Guerrero							
Hidalgo							
Jalísco							
México							
Michoacán							
Morelos							
Nayarit							
Nuevo León	6,660.7	12,565.6	66,887.9	23,746.5	191,514.2	39,994.9	22,577.8
Oaxaca							
Puebla							
Querétaro							
Quintana Roo							
San Luis Potosí							
Sinaloa							
Sonora	10,120.4	1,557.2	41,728.8	65,671.5	96,766.4	22,225.9	49,002.1
Tabasco							
Tamaulipas	11,046.1	2,102.4	48,851.3	37,039.2	108,971.2	23,191.1	37,300.5
Tlaxcala							
Veracruz							
Yucatan							
Zacatecas							
Border States	**62,802.7**	**58,856.4**	**323,710.7**	**232,586.9**	**746,993.5**	**156,867.8**	**187,435.6**
National							

Table 4-2. 1999 Area Source Emissions for Mexico, by Category
Six Northern Mexican States (Final)

Area Sources	Annual Emissions (Mg/yr)						
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Distillate- Fuel combustion-Industrial	1,269.7	315.6	10.6	264.5	52.9	12.7	
Distillate- Fuel combustion-Commercial	48.0	12.7	0.7	12.1	2.6	2.0	
Residual- Fuel combustion-Industrial	3,607.2	44,568.1	21.5	383.7	2,456.1	1,599.3	
Residual- Fuel combustion-Commercial	1,068.5	11,468.8	22.0	97.1	120.4	44.7	
LPG- Fuel combustion-Industrial	231.1	0.4	4.1	39.4	6.9	6.9	
LPG- Fuel combustion-Commercial	950.9	2.5	23.4	131.6	30.0	30.0	
LPG- Fuel combustion-Residential	4,796.9	12.7	118.3	663.7	151.1	151.1	
LPG- Fuel combustion-Agricultural	20.7	0.1	0.5	2.9	0.7	0.7	
LPG- Fuel combustion-Transportation	9,555.8	0.0	5,887.3	59,317.2	0.0	0.0	
Natural Gas- Fuel combustion-Industrial	9,353.7	20.0	183.7	2,806.1	253.9	253.9	
Natural Gas- Fuel combustion-Commercial	282.7	1.7	15.5	237.5	21.5	21.5	
Natural Gas- Fuel combustion-Residential	803.0	5.1	47.0	341.7	64.9	64.9	
Kerosene- Fuel combustion-Industrial	10.5	2.4	0.1	2.2	0.4	0.1	
Kerosene- Fuel combustion-Residential	12.5	3.4	0.5	3.5	0.2	0.1	
Kerosene- Fuel combustion-Agricultural	0.4	0.1	0.0	0.1	0.0	0.0	
Wood- Fuel combustion	735.4	105.1	13,919.6	60,615.7	8,036.6	7,736.8	
Coke-Fuel combustion	18.5	1,861.8	1,945.2	588.2	2,926.2	1,986.6	83.4
Bagasse- Fuel combustion	381.2				432.0	432.0	
Locomotives	15,605.0	138.7	588.5	1,541.5	387.5	348.2	
Aircraft	1,072.3	84.6	505.6	1,827.6			
Commercial marine vessels	11,600.1	137.6	102.0	1,142.8	284.5	277.7	
Border crossings	339.7	0.0	1998.3	21,579.5			
Gasoline distribution			20,059.7				
LPG distribution			70,649.3				
Industrial surface coatings			37,159.4				
Degreasing			57,009.8				
Architectural surface coatings			8,442.9				
Autobody refinishing			8,467.4				
Consumer solvent usage			59,174.0				
Dry cleaning			2,237.4				
Graphic arts			6,117.9				
Traffic markings			618.7				
Asphalt application			1,582.7				
Bakeries			2,080.3				
Wastewater treatment			12,674.6				
Agricultural tilling					15,512.2	3,439.1	
Agricultural burning			4,928.1	57,305.9	6,111.7	5,828.4	
Livestock ammonia							144,196.2
Fertilizer application							26,902.6
Pesticide application			3,943.6				
Beef cattle feedlots					1,219.3	139.2	

Table 4-2. Cont.

Area Sources	Annual Emissions (Mg/yr)						
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Brick kilns	31.7	0.0	413.3	1,872.1	280.6	270.1	
Charbroiling/Street vendors	48.8	0.0	170.9	2,649.0	1,330.6	1,062.0	
Open burning – Waste	690.8	115.0	985.1	9,786.4	4,374.9	4,006.6	
Wildfires	266.3	0.0	1,597.9	9,321.0	1,087.7	967.0	
Structure fires	1.3	0.0	3.3	54.0	3.4	3.2	
Construction activities					2,435.4	506.2	
Paved road dust					280,229.7	64,914.4	
Unpaved road dust					419,179.5	62,762.4	
Domestic ammonia							16,253.4
Total From Area Sources	**62,802.7**	**58,856.4**	**323,710.7**	**232,586.9**	**746,993.5**	**156,867.8**	**187,435.6**

Figure 4-1. 1999 NO_x Emissions for Mexico: Area Sources
Six Northern Mexican States (Final)

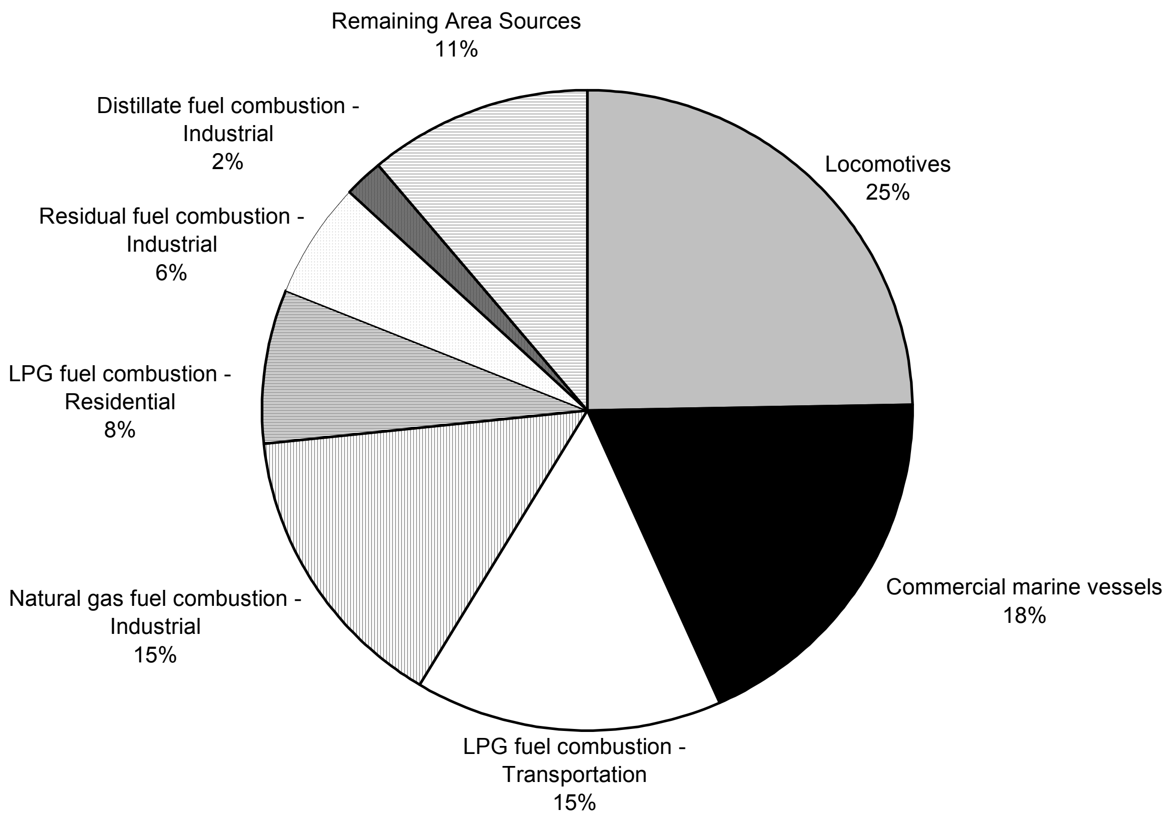


**Figure 4-2. 1999 SO_x Emissions for Mexico: Area Sources
Six Northern Mexican States (Final)**

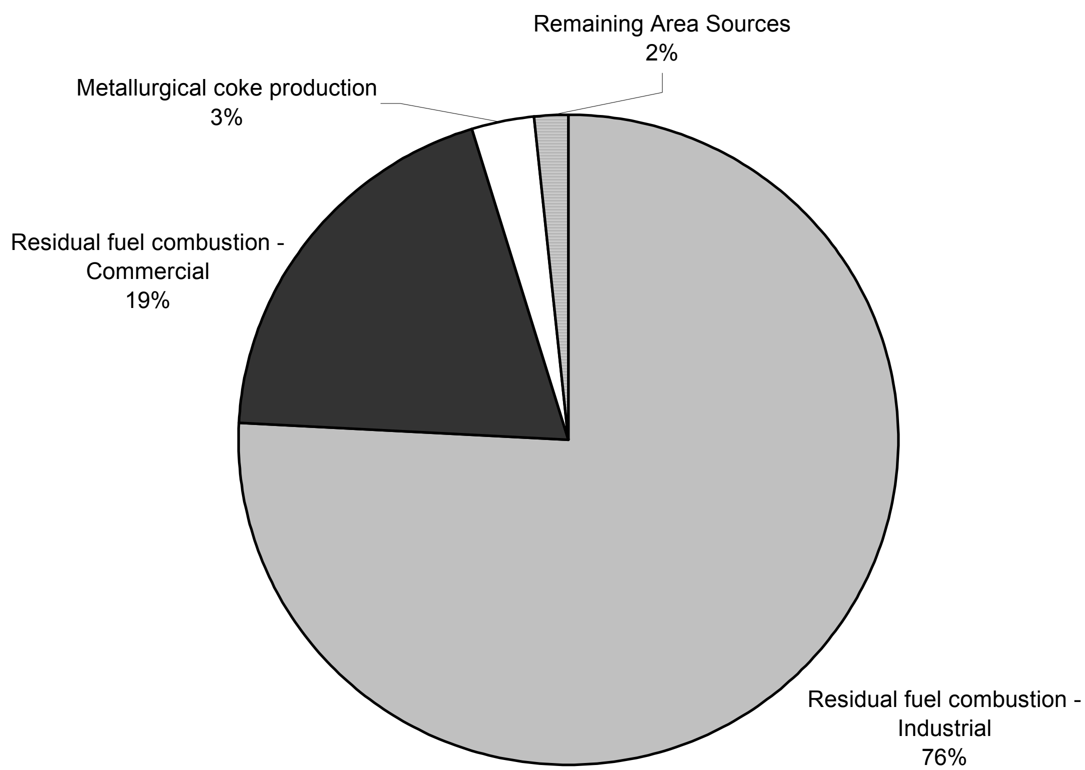


**Figure 4-3. 1999 VOC Emissions for Mexico: Area Sources
Six Northern Mexican States (Final)**

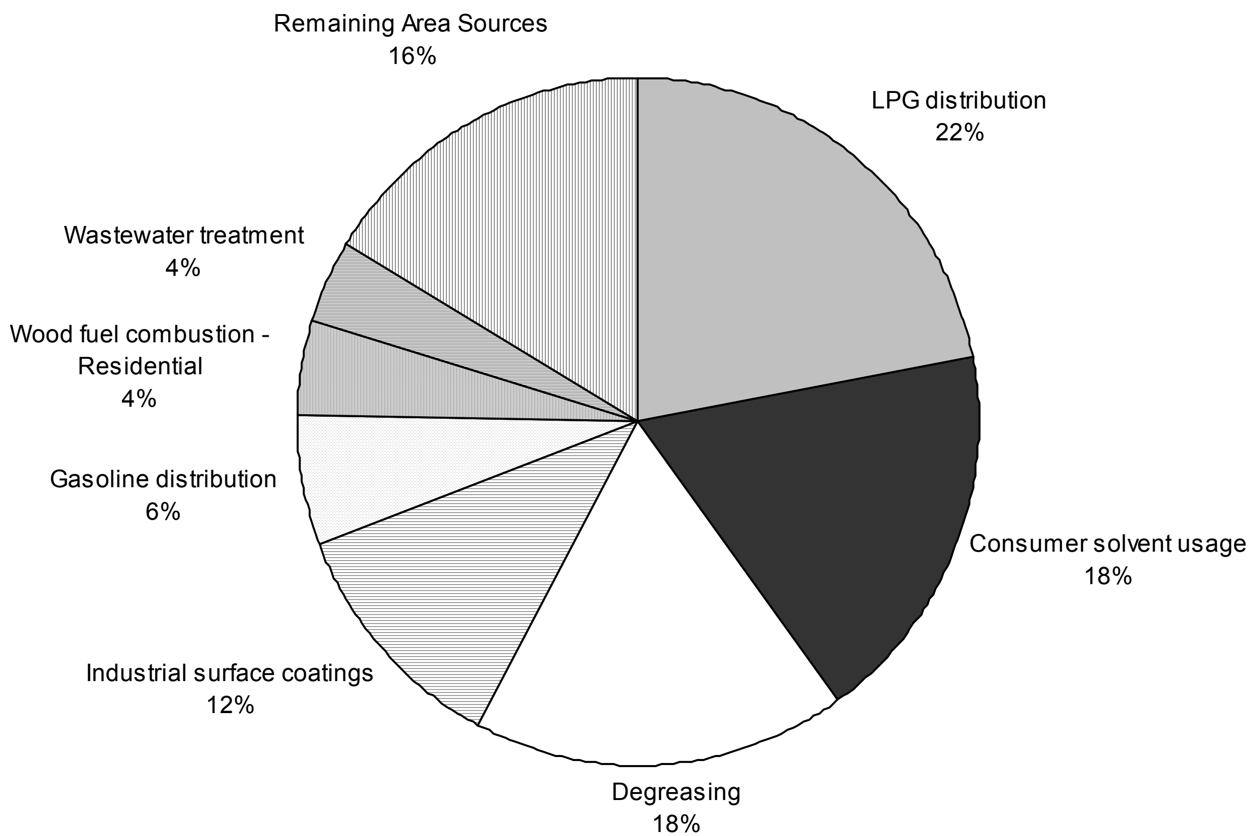


**Figure 4-4. 1999 CO Emissions for Mexico: Area Sources
Six Northern Mexican States (Final)**

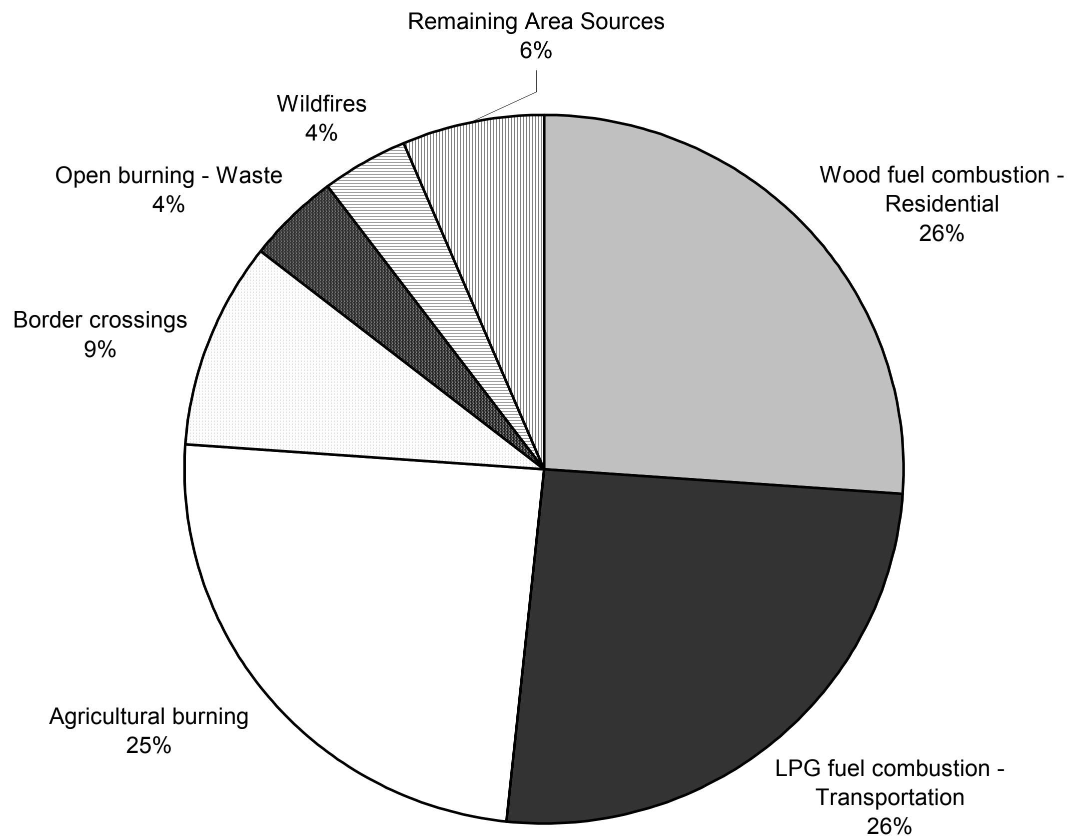


Figure 4-5. 1999 PM_{10} Emissions for Mexico: Area Sources
Six Northern Mexican States (Final)

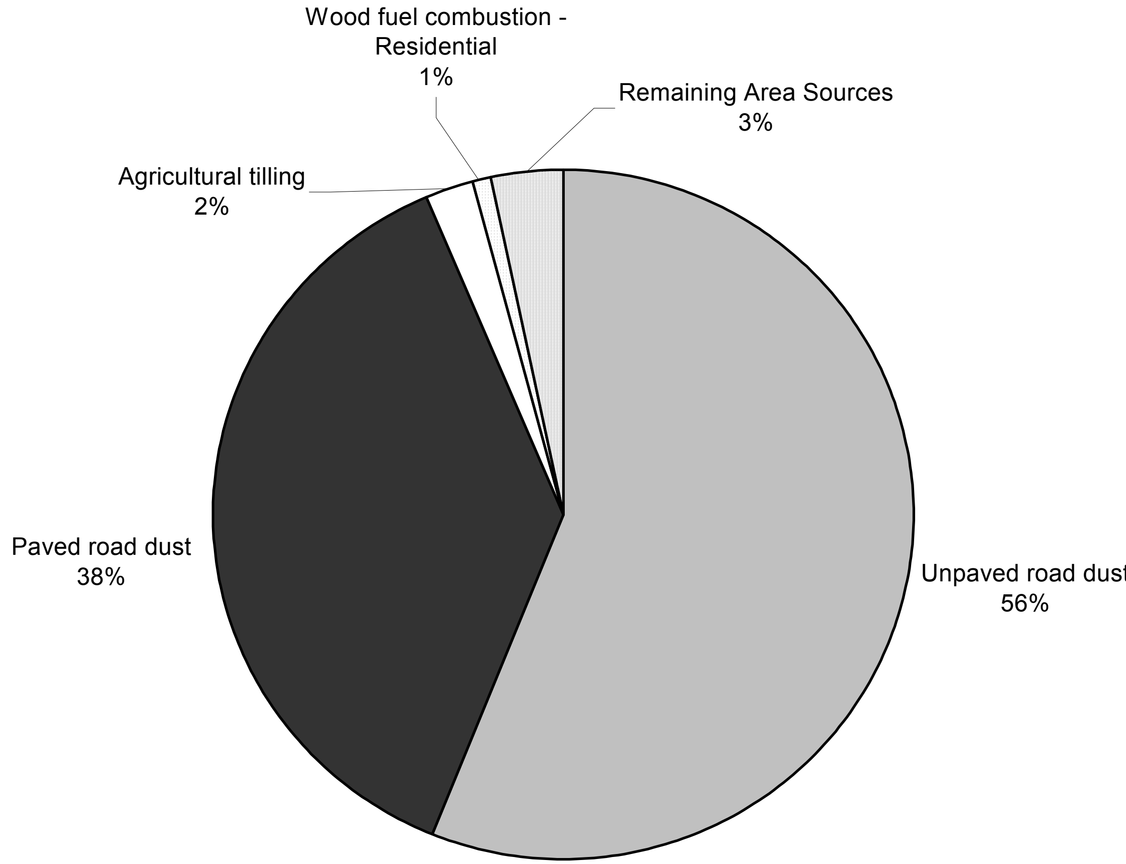


**Figure 4-6. 1999 $PM_{2.5}$ Emissions for Mexico: Area Sources
Six Northern Mexican States (Final)**

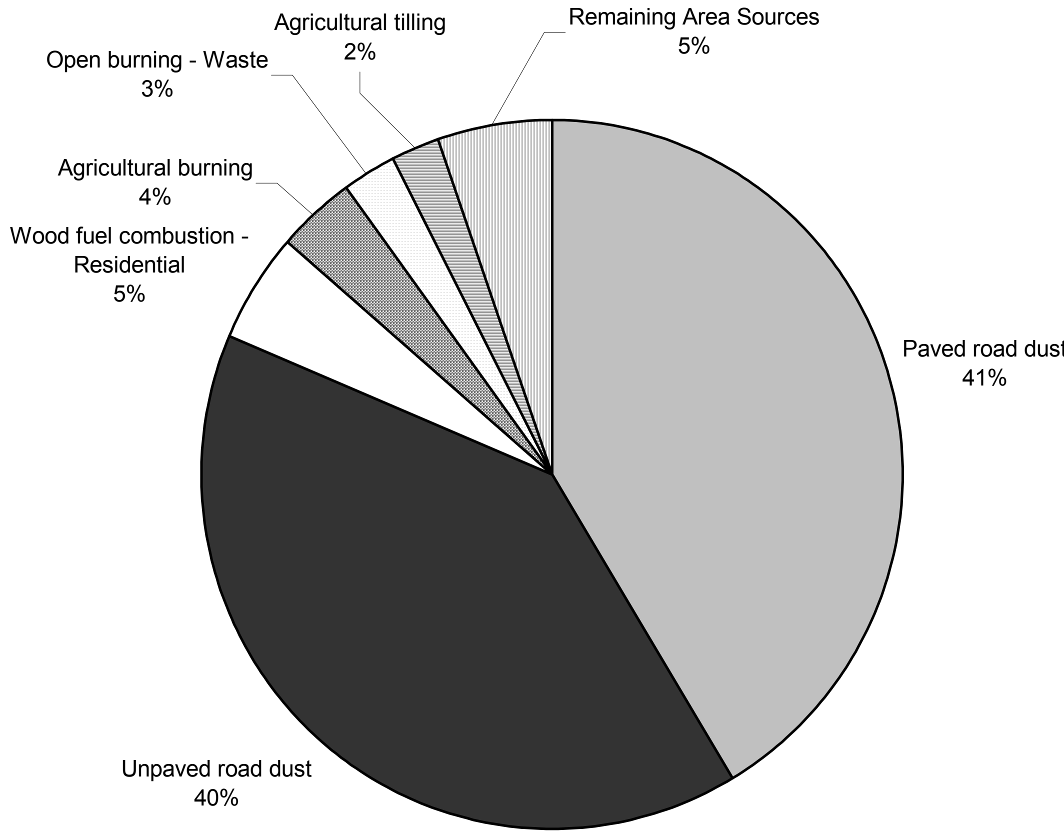


**Figure 4-7. 1999 NH_3 Emissions for Mexico: Area Sources
Six Northern Mexican States (Final)**

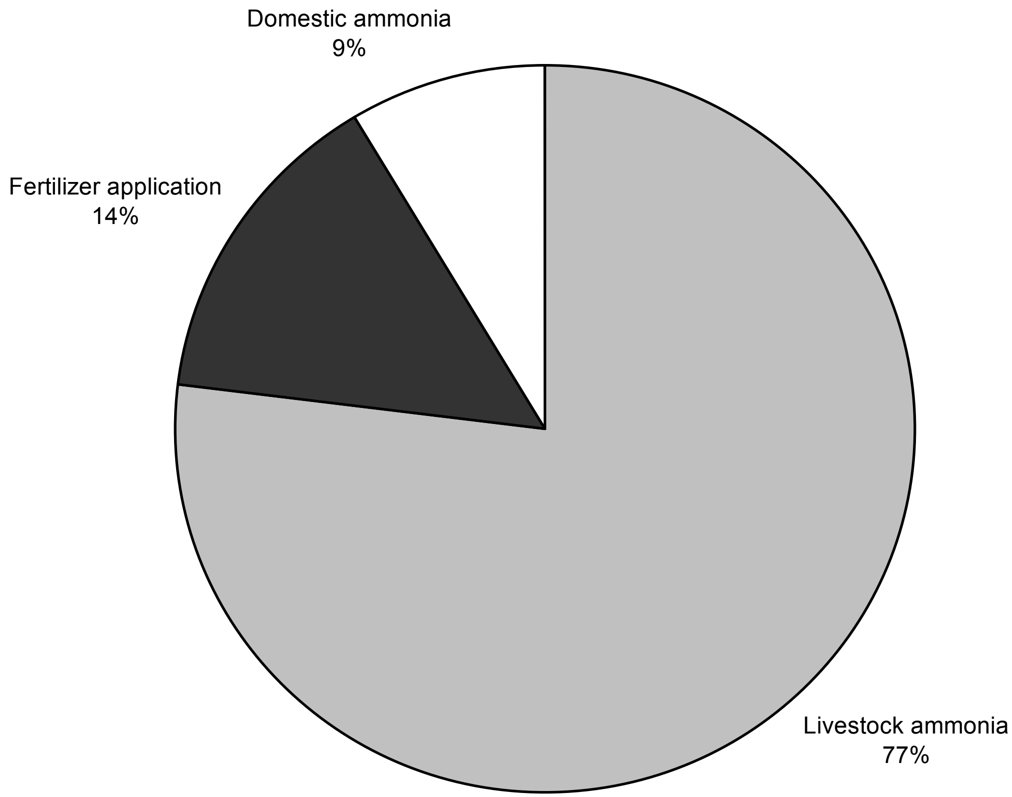


Table 4-2 shows the inventory of pollutants by source category. The inventory is also presented in Figures 4-1 through 4-7 which show the relative contributions of each source category to the 1999 annual area source emissions inventory for each pollutant. The following observations can be made regarding the results shown by these figures:

- The primary sources of NO_x emissions are locomotives and commercial marine vessels;
- SO_x emissions are predominantly from residual fuel combustion (industrial and commercial sectors);
- VOC emissions are spread over many different area source categories, with the LPG distribution, consumer solvent usage, degreasing, and industrial surface coating source categories having the highest emissions;
- CO emissions are mainly from residential wood combustion, LPG fuel combustion (transportation sector), and agricultural burning;
- Paved and unpaved road dust are the major emitters of both PM_{10} and $PM_{2.5}$; and
- Livestock ammonia is the primary source of NH_3.

4.3.1 Confidence Ratings

The confidence rating approach (as described in Section 2.3 of this report) was applied to each area source category based upon the source of activity data and emission factor(s) used to develop the emissions estimates. Each category's quality rating is shown on the second page of its source category form (Appendix C).

The activity data confidence ratings were primarily A or B ratings. This reflects the emphasis on the collection of Mexico-specific data.

The emission factor confidence ratings ranged from B to D. The B ratings were limited to source categories where either Mexico-specific emission factors already existed (i.e., LPG distribution) or per employee emission factors were derived from Mexico-specific sales data (e.g., autobody refinishing, industrial surface coating, dry cleaning, etc.). Most other categories used U.S.-based emission factors and were, consequently assigned a D. In a few instances (i.e., aircraft and commercial marine vessels), the C ratings were assigned where U.S.-

based emission factors were thought to represent overall international conditions rather than just U.S. conditions.

Because the overall quality ratings were assigned to the lower of the activity data and emission factor quality ratings, these ranged from B to D. The overall quality of the area source inventory could be improved by the following steps:

- Obtain or develop more detailed spatial allocation information for data already collected (e.g., fuels, solvent use, etc.); and
- Continue to identify potential sources of Mexico-specific emission factors.

5.0 MOTOR VEHICLES

Motor vehicles include all "on-road" mobile sources that are permitted to operate on public roadways. Aircraft, locomotives, and commercial marine vessels are included as area sources (see Section 4.0 of this report); other types of nonroad mobile equipment are described in Section 6.0 of this report. This section defines the motor vehicle categories, describes the methods used, and how the data used to estimate emissions for these sources were compiled, reviewed, and quality checked for the Mexico NEI.

The motor vehicle inventory results are presented in tabular and graphical formats to show emissions by vehicle classification and pollutant for each state, and total and relative emissions by vehicle classification and pollutant for the six northern Mexican states.

5.1 Vehicle Classifications

The motor vehicle source categories are based upon vehicle classifications that exist within the MOBILE6-Mexico emission factor model, which was used to estimate motor vehicle emissions for the Mexico NEI. These vehicle classifications are based upon vehicle type, fuel type, and gross vehicle weight rating (GVWR) in pounds (lbs.). The 28 different MOBILE6-Mexico vehicle classifications are listed below:

- Light-Duty Vehicles – Gasoline and Diesel;
- Light-Duty Trucks 1 (0-6,000 lbs. GVWR, and 0-3,750 lbs. Loaded Vehicle Weight [LVW]) – Gasoline;
- Light-Duty Trucks 2 (0-6,000 lbs. GVWR, and 3,751-5,750 lbs. LVW) – Gasoline;
- Light-Duty Trucks 3 (6,001-8,500 lbs. GVWR, and 0-5,750 lbs. Alternative Loaded Vehicle Weight [ALVW]) – Gasoline;
- Light-Duty Trucks 4 (6,001-8,500 lbs. GVWR, and >5,750 lbs. ALVW) – Gasoline;
- Light-Duty Trucks 1 and 2 (0-6,000 lbs. GVWR) – Diesel;
- Light-Duty Trucks 3 and 4 (6,001-8,500 lbs. GVWR) – Diesel;

- Class 2b Heavy-Duty Vehicles (8,501-10,000 lbs. GVWR) – Gasoline and Diesel;
- Class 3 Heavy-Duty Vehicles (10,001-14,000 lbs. GVWR) – Gasoline and Diesel;
- Class 4 Heavy-Duty Vehicles (14,001-16,000 lbs. GVWR) – Gasoline and Diesel;
- Class 5 Heavy-Duty Vehicles (16,001-19,500 lbs. GVWR) – Gasoline and Diesel;
- Class 6 Heavy-Duty Vehicles (19,501-26,000 lbs. GVWR) – Gasoline and Diesel;
- Class 7 Heavy-Duty Vehicles (26,001-33,000 lbs. GVWR) – Gasoline and Diesel;
- Class 8a Heavy-Duty Vehicles (33,001-60,000 lbs. GVWR) – Gasoline and Diesel;
- Class 8b Heavy-Duty Vehicles (>60,000 lbs. GVWR) – Gasoline and Diesel;
- School, Transit and Urban Buses – Gasoline;
- Transit and Urban Buses – Diesel;
- School Buses – Diesel; and
- Motorcycles – Gasoline.

Although these vehicle classifications provide considerable detail, reporting emissions for all 28 vehicle classifications can create data management challenges. Therefore, motor vehicle emission results for the Mexico NEI are aggregated up to the following 7 vehicle classifications:

- Light-Duty Gasoline Vehicles (LDGV);
- Light-Duty Gasoline Trucks (LDGT);
- Heavy-Duty Gasoline Vehicles (HDGV);
- Light-Duty Diesel Vehicles (LDDV);
- Light-Duty Diesel Trucks (LDDT);

- Heavy-Duty Diesel Vehicles (HDDV); and
- Motorcycles (MC).

Most of this aggregation occurs within the heavy-duty vehicle classifications (e.g., 8 detailed heavy-duty vehicle classifications are aggregated into a single general heavy-duty classification).

5.2 Methodology

Motor vehicle emissions for NO_x, SO_x, VOC, CO, PM_{10}, $PM_{2.5}$, and NH_3 were calculated using activity data and emission factors generated by the MOBILE6-Mexico emission factor model (ERG, 2003b). Motor vehicle activity data consisted of vehicle kilometers traveled (VKT) and emission factors were estimated on a grams per VKT basis. VKT was estimated by multiplying daily per capita VKT generation rates by the municipality-level population. Mexico-specific emission factors were estimated using the MOBILE6-Mexico emission factor model, which was developed from U.S. EPA's MOBILE6.2 model (U.S. EPA, 2002a) and modified using Mexico-specific data. Emission results for SO_x, PM_{10}, and $PM_{2.5}$ were adjusted to account for gasoline and diesel sulfur contents provided by PEMEX (PEMEX, 2004). Development of the per capita VKT generation rates is described in more detail in Section 5.2.1, and development of the MOBILE6-Mexico emission factor model is described in Section 5.2.2, below.

5.2.1 Per Capita VKT Generation Rates

The availability of motor vehicle activity data (i.e., VKT) on a state- and municipality-level for Mexico is quite limited, and this presented a challenge for developing motor vehicle emission estimates for the Mexico NEI. Travel demand models (TDMs) are the preferred method for estimating vehicle activity; however, these are not widely used in Mexico. Furthermore, developing TDMs for the entire country for the Mexico NEI was not technically or economically feasible. In several of the existing Air Quality Plan emissions inventories discussed in Section 1.2 (GDF, 2003; GJ, 1997; GNL, 1997; GCh, 1998; GM, 1997; GBC, 1999; and GBC, 2000), VKT were estimated using vehicle registration statistics combined with assumed daily VKT based upon some limited traffic count statistics, informal surveys, and anecdotal information. In an alternative approach, fuel sales data can be used to estimate VKT, if assumptions regarding fuel efficiencies for various vehicle classifications are made. As described in Section 4.2.2, PEMEX fuel sales data were obtained for the 81 bulk terminals in Mexico

(PEMEX, 2003b). However, the PEMEX fuel sales data were not available at the municipality-level that is needed for the Mexico NEI.

In order to develop municipality-level VKT estimates for the entire country, a unique methodology was developed for the Mexico NEI. This methodology is based upon modeled traffic volumes and congestion levels for representative urban areas of different size (i.e., population). Because larger cities will tend to have more frequent and more intense traffic congestion, this methodology differentiates between traffic congestion and emissions per capita for urban areas of different sizes. Seven urban area size categories were established and the following urban areas were selected to represent each categories:

- Small towns (<25,000 population) – Castaños, Coahuila;
- Medium towns (25,000 to 100,000 population) – Río Bravo, Tamaulipas;
- Large towns (100,000 to 250,000 population) – Ensenada, Baja California;
- Small cities (250,000 to 1,000,000 population) – Hermosillo, Sonora;
- Medium cities (1,000,000 to 2,000,000 population) – Ciudad Juárez, Chihuahua;
- Large cities (>2,000,000 population) – Monterrey, Nuevo León; and
- Mexico City.

Traffic volume and congestion modeling was conducted for each of these seven representative urban areas. The traffic volume and congestion modeling used a simplified roadway network which included freeways, main arterials, collector roads, and "connectors" (i.e., artificial links that modeled local traffic flows). The traffic model provided daily VKT estimates for daily traffic volumes for each link in the roadway networks. Link-level VKT were then estimated by multiplying each link's daily traffic volume by its length in kilometers. Summing link-level VKT for all links in a roadway network provided total VKT for a particular urban area. Daily per capita VKT rates for each representative urban area were then derived by dividing total VKT for each urban area by the population in each respective area. The resulting daily per capita VKT rates are listed below:

- Small towns (<25,000 population) – 1.6 VKT/person-day;
- Medium towns (25,000 to 100,000 population) – 1.6 VKT/person-day;
- Large towns (100,000 to 250,000 population) – 4.3 VKT/person-day;
- Small cities (250,000 to 1,000,000 population) – 5.2 VKT/person-day;
- Medium cities (1,000,000 to 2,000,000 population) – 6.2 VKT/person-day;
- Large cities (>2,000,000 population) – 9.4 VKT/person-day; and
- Mexico City – 6.3 VKT/person-day.

Next, motor vehicle traffic volumes for individual roadway network links were assigned and combined with corresponding link-specific congested speed emission factors to estimate daily emissions on a link basis using PrepinPlus software. The congested speed emission factors were developed using MOBILE6-Mexico (see Section 5.2.2). Several sets of emission factors were developed to account for different congested speeds (i.e., from 3 to 65 mph), variations in ambient temperature, season, and altitude for different urban areas within a particular urban area size category. A more detailed description of the development of daily per capita emission rates is provided in the technical memorandum located in Appendix A (TransEngineering, 2004).

Daily per capita emission rates for each of the representative urban areas were applied to other urban areas of similar size. Annual municipality-level on-road motor vehicle emission estimates were estimated by multiplying the assigned daily per capita emission rates by municipality-level population.

5.2.2 MOBILE6-Mexico Emission Factor Model

The U.S. EPA's MOBILE6 model was modified in four major areas: basic emission factors, fuel specifications, fleet age distribution, and driving patterns.

For older gasoline powered vehicles, data collected on in-use vehicles in Mexico were analyzed to develop new basic emission factors for Mexican vehicles. For newer gasoline powered vehicles, assumptions were developed from similar empirical data about the relative emissions levels of Mexican vehicles as compared to U.S. vehicles. For future model years, it was assumed that Mexican vehicles will acquire about the same levels of pollution control as U.S. vehicles by the year 2010. For all diesel powered vehicles, assumptions from the MOBILE5-Mexico model were transferred to the MOBILE6-Mexico model.

Actual Mexican fuel parameters were determined by assuming that Mexican fuels have the same relationship with their fuel standards as is found in the U.S. Actual fuel parameters in the U.S. were compared to U.S. fuel standards, and the same relationship was assumed for Mexican fuels.

Several data sources were used to develop default assumptions about the fleet age distribution in Mexico. National vehicles sales data were compared to recent registration data from Ciudad Juárez (ERG, 2001) and on-road data from recently collected vehicle remote sensing data from Mexico City (Shifter et al., 2003). The data indicated that vehicle age distributions in Mexico are radically different than those in the U.S. and are highly influenced by economic and political considerations within Mexico.

Only diurnal vehicle usage patterns were changed. Data that were collected during a driving study in Aguascalientes were used to modify vehicle soak patterns (i.e., how long the vehicles are turned off overnight and during other low-use times of the day) (Radian, 1998).

5.2.3 Quality Assurance

Quality reviews were conducted during the development of the motor vehicle inventory according to the QA Plan contained in the Mexico NEI Inventory Preparation Plan (ERG, 2003a). Specific QA checks were as follows:

- Municipality-level VKT estimates summed for the entire country were compared to a VKT estimate derived from the national fuels balance (ERG, 2003d).
- Emission factors generated for each of the seven representative urban areas representing various scenarios (i.e., high and low altitude, high and moderate temperature ranges, and winter and summer seasons) were reviewed for reasonableness.

- National-, state-, and municipality-level emission estimates were reviewed for reasonableness. Internal state- and municipality-level comparisons were conducted. Also, some comparisons with existing Air Quality Plan inventories and U.S. inventories were performed.

All errors discovered during the QA review were corrected.

5.3 Results by Vehicle Classification

The results of the final 1999 motor vehicle emissions inventory for the six northern Mexican states are shown in Tables 5-1 and 5-2, and Figures 5-1 through 5-7. Emissions in Mg/year for each vehicle classification, by state and pollutant, are provided in Appendix D.

Table 5-1 shows that the state of Nuevo León has the most motor vehicle emissions for all pollutants, followed by the states of Chihuahua and Baja California. This is an expected result because the five largest metropolitan areas in the northern border states (i.e., Monterrey, Ciudad Juárez, Chihuahua City, Tijuana, and Mexicali) are located in these three states. The significant difference in emissions between Nuevo León and the states of Chihuahua and Baja California is primarily due to the higher daily per capita VKT in Monterrey (9.4 VKT/person-day versus 6.2 VKT/person-day or less). Table 5-2 shows the inventory of pollutants by vehicle classification.

Figures 5-1 through 5-7 show relative contributions of each source category to the 1999 annual motor vehicle emissions inventory. The following observations can be made regarding the results shown by these figures:

- Most of the VOC and CO emissions are from light-duty gasoline vehicles and light-duty gasoline trucks. This is expected primarily due to the relatively higher VKT and emission factors for these vehicle classifications; and

- Even though light-duty gasoline vehicles and light-duty gasoline trucks make up a large fraction of the total VKT, heavy-duty diesel vehicles are the most significant source category of NO_x, PM_{10}, and $PM_{2.5}$. This is because the heavy-duty diesel vehicle NO_x, PM_{10}, and $PM_{2.5}$ emission factors are considerably higher than for light-duty gasoline vehicles and trucks.

Table 5-1. 1999 Motor Vehicle Emissions for Mexico, by State
Six Northern Mexican States (Final)

State Name	Annual Emissions (Mg/year)						
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Aguascalientes							
Baja California	13,238.6	751.8	16,053.3	123,056.3	392.7	321.6	244.1
Baja California Sur							
Campeche							
Coahuila	10,338.6	590.0	12,611.0	105,014.5	308.0	252.2	169.3
Colima							
Chiapas							
Chihuahua	14,319.1	812.6	17,642.2	146,114.3	424.5	347.7	247.6
Distrito Federal							
Durango							
Guanajuato							
Guerrero							
Hidalgo							
Jalísco							
México							
Michoacán							
Morelos							
Nayarit							
Nuevo León	36,605.1	1,945.6	47,589.3	355,070.0	1,016.1	832.3	562.8
Oaxaca							
Puebla							
Querétaro							
Quintana Roo							
San Luis Potosí							
Sinaloa							
Sonora	7,905.5	452.2	9,559.4	73,532.7	236.2	193.5	153.6
Tabasco							
Tamaulipas	12,271.7	698.5	14,714.2	113,633.7	364.6	298.7	219.4
Tlaxcala							
Veracruz							
Yucatan							
Zacatecas							
Border States	**94,678.6**	**5,250.7**	**118,169.4**	**916,421.5**	**2,742.1**	**2,246.0**	**1,596.8**
National							

Table 5-2. 1999 Motor Vehicle Emissions for Mexico, by Category Six Northern Mexican States (Final)

Mobile (On-Road) Sources	Annual Emissions (Mg/year)						
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Light-Duty Gasoline Vehicles	20,289.2	2,122.5	68,715.7	507,177.6	329.1	188.8	884.9
Light-Duty Gasoline Trucks	13,069.9	1,876.4	37,750.7	329,365.0	259.0	156.8	607.5
Heavy-Duty Gasoline Vehicles	3,005.4	311.7	5,332.9	45,115.8	79.8	56.0	25.0
Light-Duty Diesel Vehicles	144.0	6.7	127.3	253.8	30.8	27.5	0.7
Light-Duty Diesel Trucks	75.1	4.2	69.0	134.3	12.1	10.7	0.1
Heavy-Duty Diesel Vehicles	57,836.5	903.2	5,421.7	29,216.9	2,021.5	1,800.6	75.5
Motor Cycles	258.4	26.0	752.1	5,158.1	9.8	5.6	3.1
Total from Motor Vehicles	**94,678.5**	**5,250.7**	**118,169.4**	**916,421.5**	**2,742.1**	**2,246.0**	**1,596.8**

Figure 5-1. 1999 NO_x Emissions for Mexico: Motor Vehicles
Six Northern Mexican States (Final)

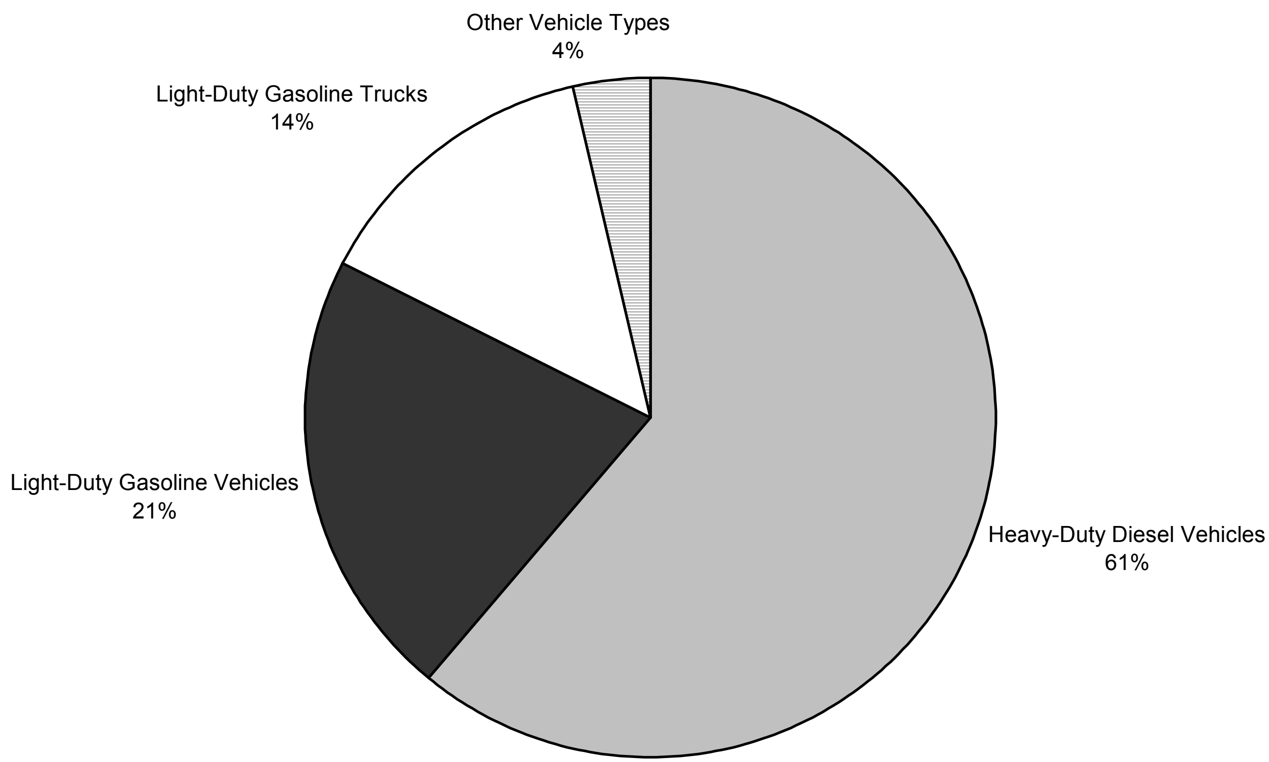


Figure 5-2. 1999 SO_x Emissions for Mexico: Motor Vehicles Six Northern Mexican States (Final)

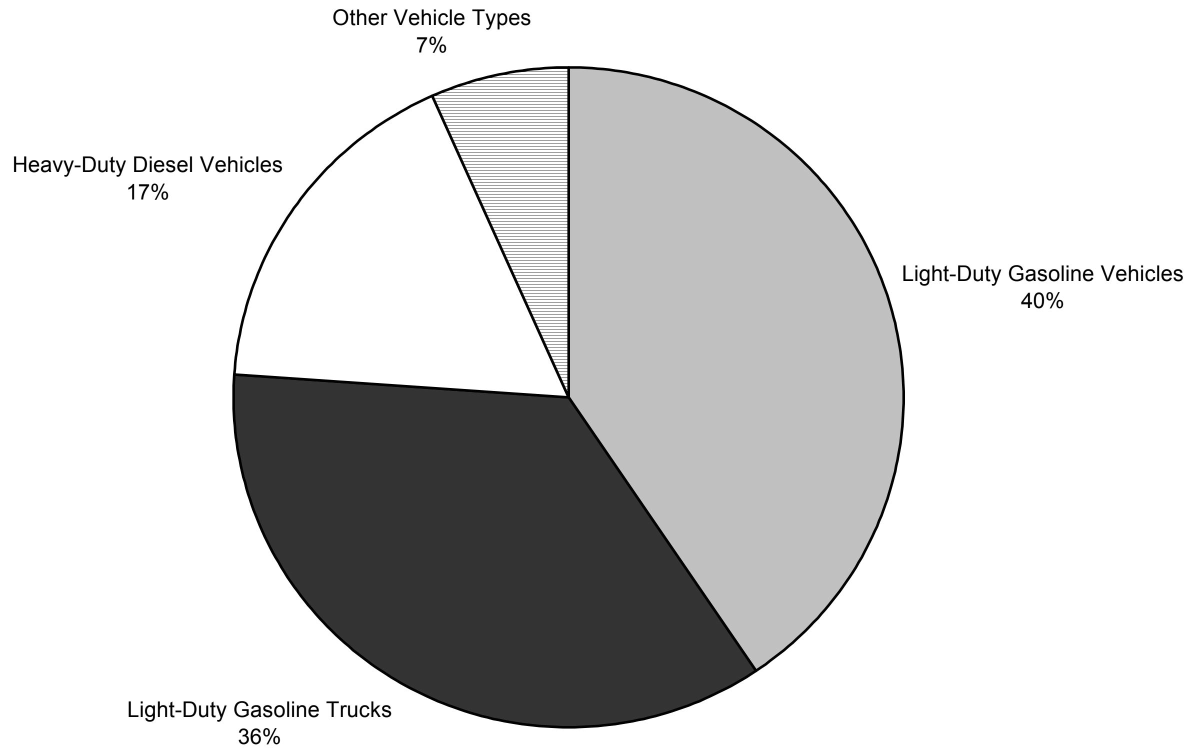


Figure 5-3. 1999 VOC Emissions for Mexico: Motor Vehicles
Six Northern Mexican States (Final)

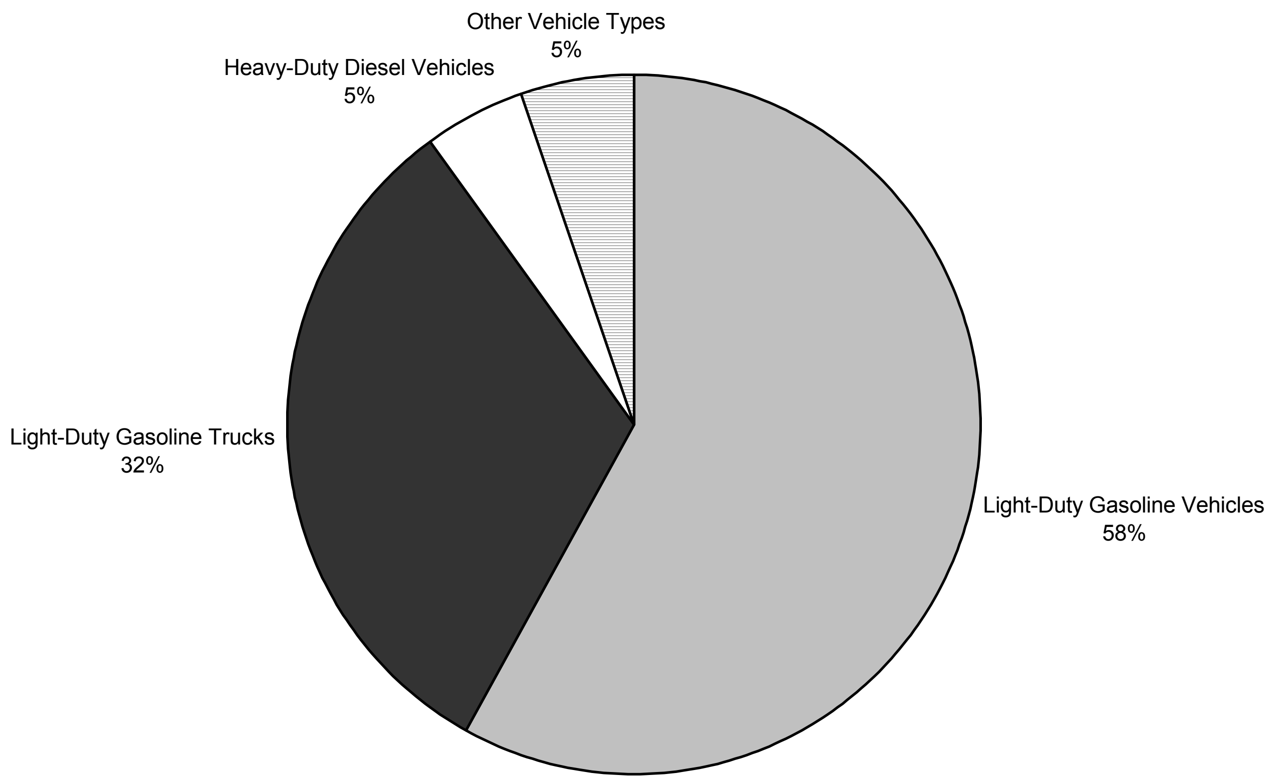


Figure 5-4. 1999 CO Emissions for Mexico: Motor Vehicles
Six Northern Mexican States (Final)

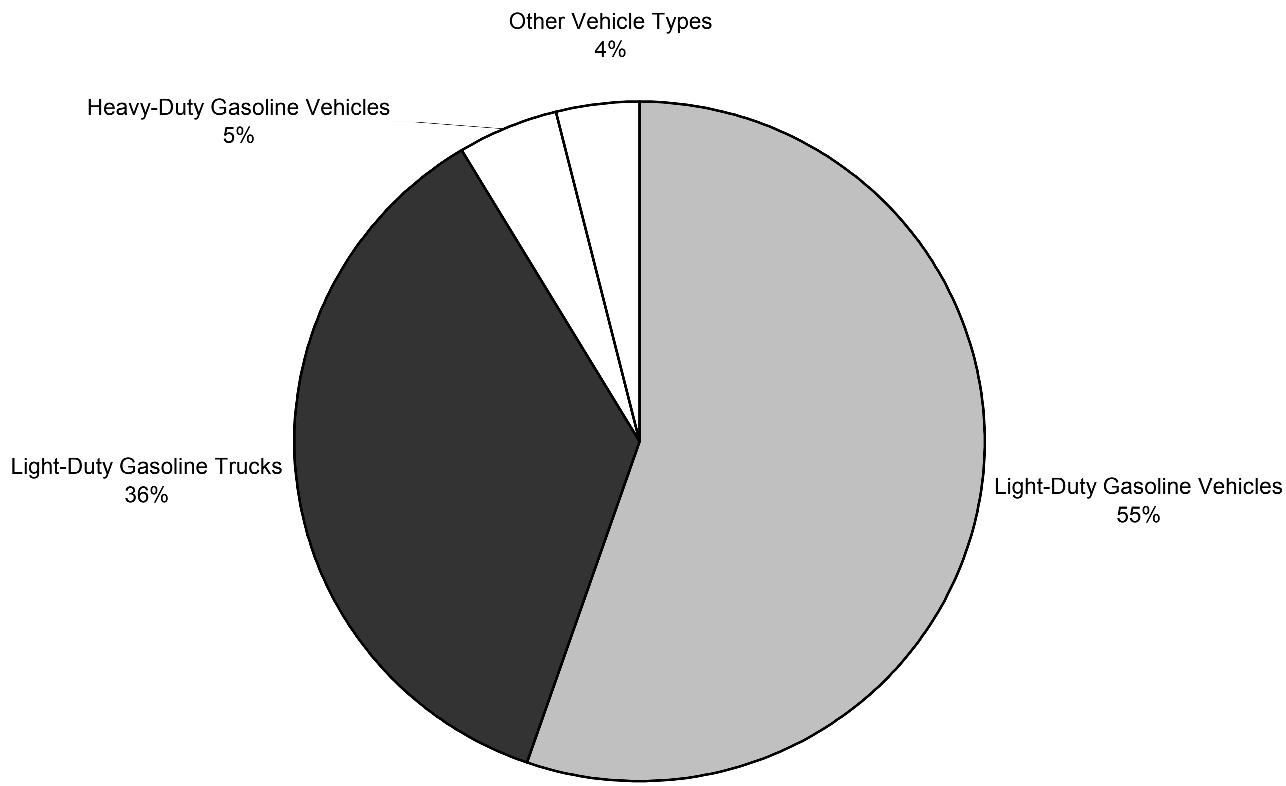


**Figure 5-5. 1999 PM_{10} Emissions for Mexico: Motor Vehicles
Six Northern Mexican States (Final)**

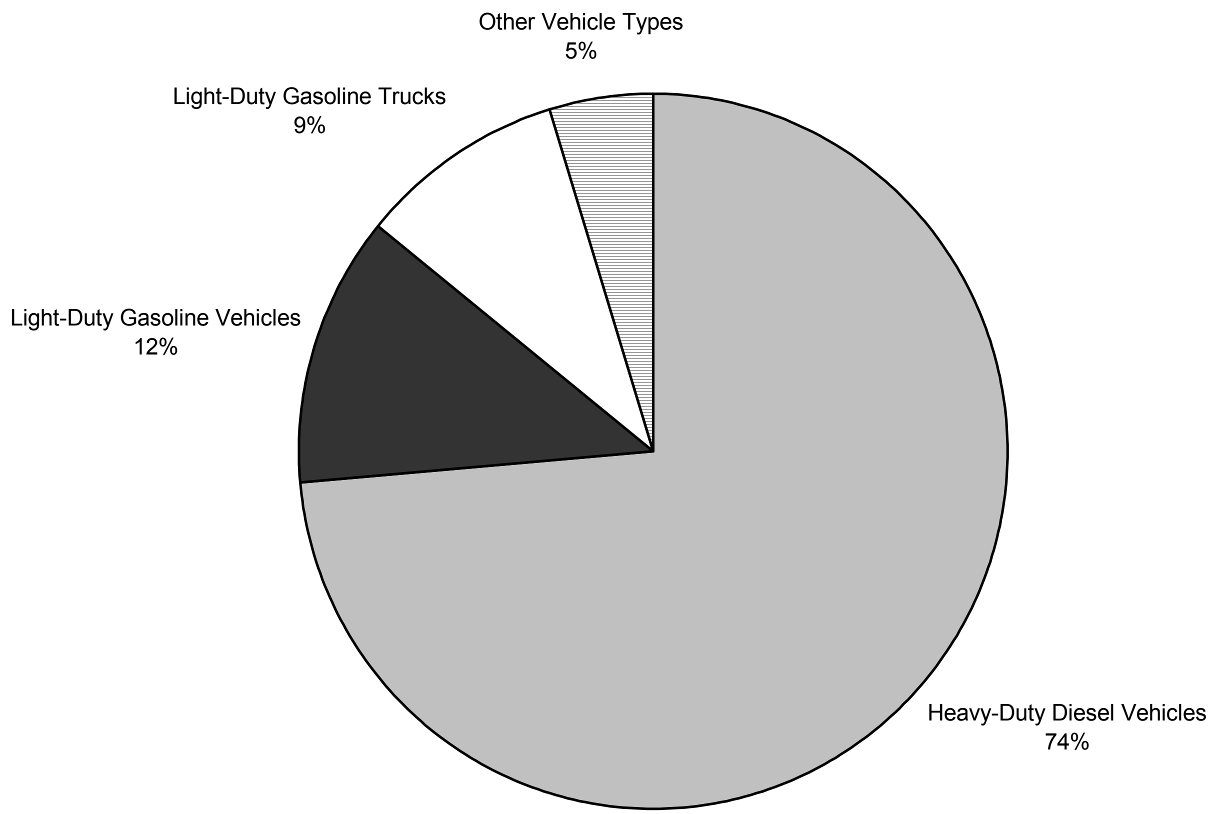


Figure 5-6. 1999 $PM_{2.5}$ Emissions for Mexico: Motor Vehicles
Six Northern Mexican States (Final)

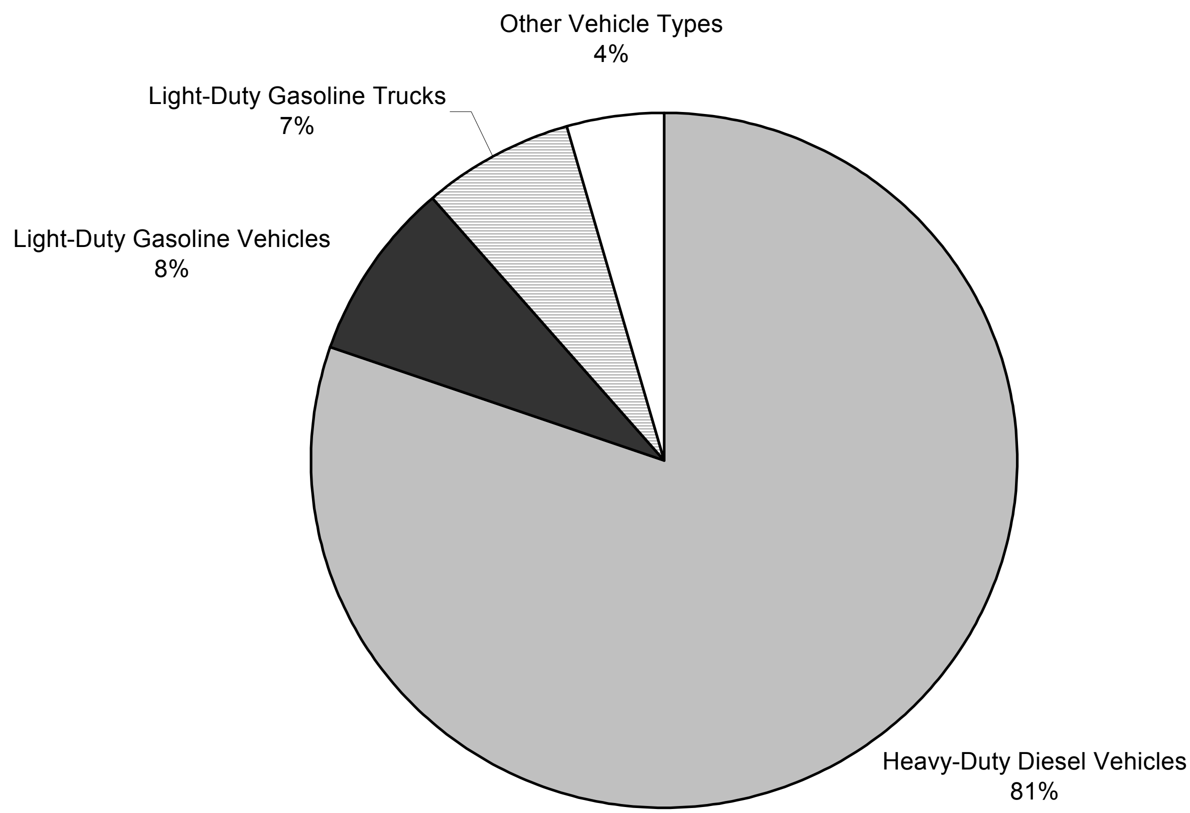
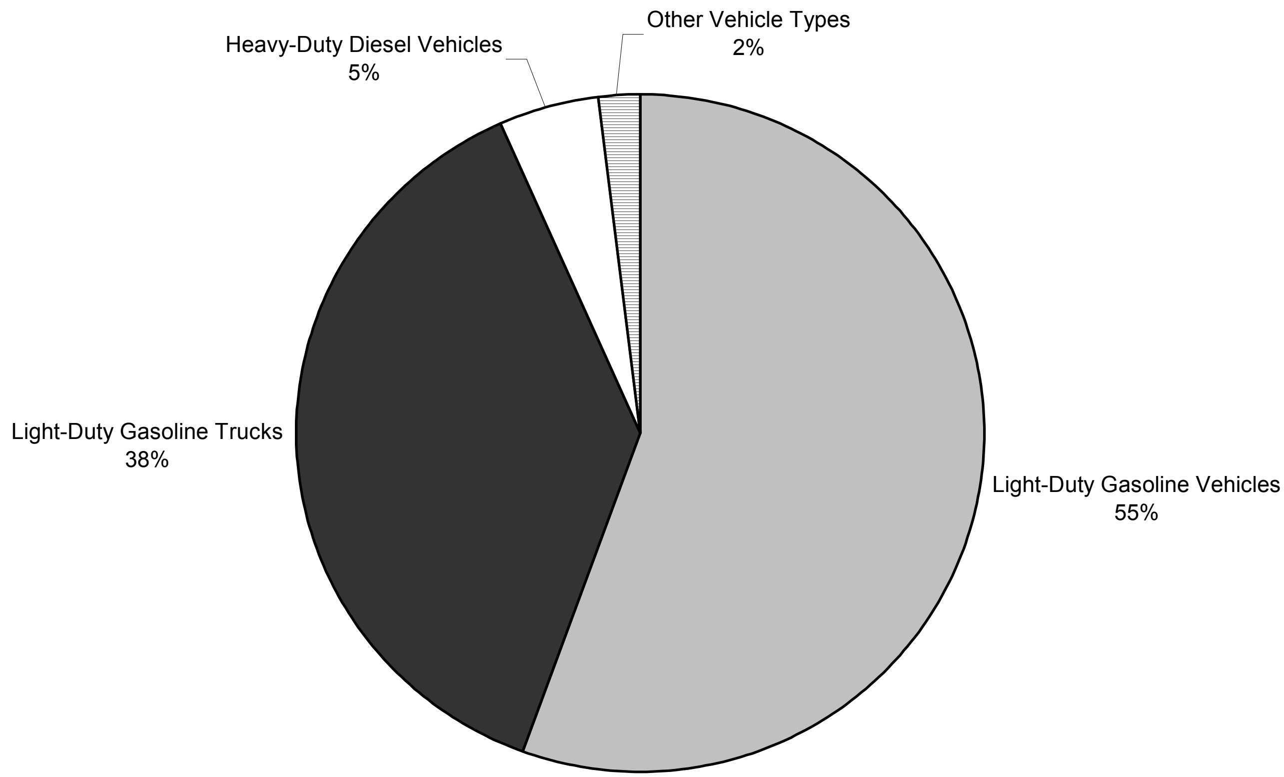


**Figure 5-7. 1999 NH_3 Emissions for Mexico: Motor Vehicles
Six Northern Mexican States (Final)**



6.0 NONROAD MOBILE SOURCES

Nonroad mobile sources include all "off-road" equipment that can move under their own power, or are portable, but are not permitted to operate on public roadways. For purposes of the Mexico NEI, this category is limited to equipment used in construction and agricultural activity. Aircraft, locomotives, and commercial marine vessels are included as area sources (see Section 4.0 of this report). Nonroad mobile sources also include a number of other equipment types, including equipment used in industrial and commercial activities (e.g., welders, air compressors, aerial lifts, etc.), recreational vehicles and boats, lawn and garden equipment, oil field and airport service support equipment, and logging equipment. These other nonroad source categories are more difficult to quantify and typically lower in emissions contribution, thus they are not included in the Mexico NEI at this time.

This section defines the agricultural and construction equipment categories, describes the methods used, and how the data used to estimate emissions for these sources were compiled, reviewed, and quality checked for the Mexico NEI. The inventory results are presented in tabular format to show emissions by pollutant for each state, and total and relative emissions by source category and pollutant for the entire country.

6.1 Equipment Classifications

The nonroad equipment source categories are based upon the classifications that exist within U.S. EPA's NONROAD2002 emission factor model (currently being modified to reflect Mexico conditions as NONROAD-Mexico), which was used to estimate nonroad emissions for the Mexico NEI (U.S. EPA, 2002b). These equipment classifications are based upon engine type, power, and fuel type. Many equipment types feature different fuel options, including diesel, 2 and 4-stroke gasoline, propane (LPG), and natural gas. The NONROAD2002 model also groups engines by horsepower bin, ranging from 1 to over 1,000 horsepower (hp), depending on the application.

The different NONROAD2002 equipment classifications are listed below, irrespective of horsepower grouping and fuel type:

Construction Equipment		Agricultural Equipment
Pavers	Graders	2-wheel tractors
Plate compactors	Off-highway trucks	Agricultural mowers
Rollers	Crushing/processing equipment	Agricultural tractors
Scrapers	Rough terrain forklifts	Balers
Paving equipment	Rubber tire loaders	Combines
Surfacing equipment	Rubber tire tractors/dozers	Hydraulically-powered equipment
Signal boards/light plants	Tractors/loaders/backhoes	
Trenchers	Crawler tractors/dozers	Sprayers
Bore/drill rigs	Skid steer loaders	Swathers
Excavators	Off-highway tractors	Tillers >6 horsepower
Concrete/industrial saws	Dumpers/tenders	Irrigation pumps
Cement and mortar mixers	Other construction equipment	Other agricultural equipment
Cranes		

According to the NONROAD2002 model, most agricultural equipment uses diesel fuel. This is confirmed by the national fuels balance (see Section 4.2.2 of this report) which indicates only very small volumes of LPG consumption for this sector. However, these same data did not provide an estimate for gasoline use in the agricultural sector. Since gasoline consumption was not reported for this sector in Mexico, and since gasoline use accounts for only about 2 percent of total fuel use in the agricultural sector in the U.S., it was assumed that emissions from gasoline powered agricultural equipment were insignificant. Therefore this analysis evaluated emissions from diesel fueled agricultural equipment only. The analysis of construction equipment included all fuel types found in the NONROAD model however.

6.2 Methodology

Annual nonroad equipment emissions for NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$ were calculated using activity data from various sources and emission factors generated by the NONROAD2002 emission factor model, modified to reflect Mexico-specific conditions. Ammonia is not estimated by the NONROAD2002 model and therefore is not included in the Mexico NEI for agricultural and construction equipment. Nonroad equipment activity data consist of estimated horsepower-hours of operation for each equipment type/fuel/hp range combination. These estimates were then combined with emission factors from the NONROAD2002 model for the corresponding equipment/fuel/hp groupings, expressed in terms of grams per hp-hour.

Selected parameters in the NONROAD2002 model were modified to reflect Mexico-specific conditions. Standard model inputs include ambient temperatures, fuel quality (sulfur content, gasoline RVP and oxygenate content), and altitude. Average annual temperatures were calculated for each state using weather station data (NCDC, 2003). Altitude impacts combustion processes, and therefore emission factors. It was assumed that the NONROAD2002 model follows the MOBILE emission factor model convention, with areas above 1,400 meters designated as "high" altitude (although no cut off could be found in the NONROAD2002 documentation). Average temperatures and altitudes are summarized in Table 6-1 for the six northern states.

The fuel quality parameters used as inputs to the NONROAD model were obtained from PEMEX (PEMEX, 2004) and are as follows:

Fuel Parameter	Annual Average Value
RVP	8.0
Oxygenate (% wt)	0.0
Gasoline Sulfur (%)	0.1
Diesel Sulfur (%)	0.4

Since NONROAD2002 was run using annual average conditions, Reid vapor pressure (RVP) was taken as the average of summer (6.5) and winter (9.5) values.

Additional changes were made to selected NONROAD2002 external files to reflect Mexico-specific conditions. First, NONROAD2002's TECH.DAT file was modified to set all emission standards equal to baseline (uncontrolled) levels through the 1999 calendar year, since Mexico has no emission standards for nonroad engine categories for this time period.

Next, equipment population estimates were modified for both agricultural and construction equipment using different data. State-specific data was available for diesel agricultural tractors and pumps from 1990, along with percentage breakouts by horsepower (INEGI, 1990a). This data is presented in Table 6-2 for the six northern states. Data for these two equipment types were entered directly into the NONROAD2002 external equipment population files by the appropriate horsepower bins, creating one file for each state. Other

Table 6-1. Annual Average Temperatures and Altitude Category for the Six Northern States

State Code	State Name	Average Temp (ºF)	Average Altitude Category
02	Baja California	64	Low
05	Coahuila	73	Low
08	Chihuahua	64	High
19	Nuevo León	74	Low
26	Sonora	67	Low
28	Tamaulipas	75	Low

Table 6-2. Tractor and Irrigation Equipment Populations for the Six Northern States, 1999

State	Tractors						Irrigation Sets			
	Total	Percentage of Total in Each Size					Total	Percentage of Total in Each Size		
		1-50 hp	51-100 hp	101-150 hp	150-200 hp	200+hp		1-50 hp	51-100 hp	101-150
Baja California	3,271	4.04	45.61	34.15	10.85	5.35	138	35.51	52.90	11.59
Coahuila	4,704	3.10	81.31	12.33	2.17	1.08	109	63.30	33.03	3.67
Chihuahua	26,550	6.54	65.04	20.74	6.28	1.40	242	40.91	38.43	20.66
Nuevo León	3,169	1.64	68.07	21.08	7.38	1.83	16	50.00	43.75	6.25
Sonora	9,248	1.34	59.29	24.30	12.22	2.85	220	43.64	43.64	12.73
Tamaulipas	23,294	1.47	37.94	39.37	18.38	2.83	252	16.67	48.41	34.92

agricultural equipment populations (e.g., balers) were assumed to be present in the same proportion as in the U.S. Therefore, U.S. national default populations were used to ratio these other equipment types based on tractor populations. (With the exception of CO emissions, agricultural tractors and irrigation sets account for the vast majority of emissions in the U.S. for this sector. Therefore, to the extent that the mix of equipment in Mexico is similar to that in the U.S., this simplification should not introduce large errors in the emissions inventory.)

Finally, annual diesel fuel use was available for the agricultural sector in Mexico from the national fuels balance (i.e., 31,676 bbl/day, or 486 million gal/yr). This was compared with NONROAD2002's estimated fuel consumption for the Mexico-specific equipment populations to obtain an adjustment factor for equipment activity (hrs/year/unit). The national level fuel consumption levels were 15 percent lower than that predicted by the NONROAD2002 model using U.S. default hour per year values. Therefore the NONROAD2002's ACTIVITY.DAT file was adjusted to reflect a 15 percent decrease in hours/year for diesel agricultural equipment.

No reliable vehicle population data were available concerning construction equipment in Mexico. Therefore, a number of different surrogates were evaluated for use in extrapolating U.S. equipment population data to Mexico. These included gross domestic product for the construction sector, book value of all assets, field workers employed, and general population. It was determined that the number of employees actually working at job sites, available for each state, was the best indicator of likely equipment usage. (The ratio of labor to equipment utilization in the construction sector is being investigated for use with NONROAD-Mexico model currently being developed by ERG.)

The total number of employed construction workers in Mexico in 1998 was obtained from the *Census Económicos* (INEGI, 1999b) that indicated that 538,375 field workers (*obreros*) employed. Comparable employment statistics for the U.S. indicated 4,332,737 construction workers employed nationally in 1997 (U.S. Census, 1997). (No adjustment was made to correct for the one-year discrepancy in employment figures between the two countries.) The ratio of these two figures, 0.124, was applied to the U.S. equipment totals in the NONROAD 2002 equipment population files to estimate Mexico equipment populations at the national level. Then, state level totals were derived from the fraction of total construction workers by state in the year 2000 (INEGI, 2003), which are summarized in Table 6-3. No direct operations data was available for construction equipment, including fuel use, so U.S. defaults values for hours per year were used.

Once all inputs and external files were compiled, separate NONROAD2002 runs were performed for each state to obtain annual emissions in tons per year for the selected pollutants. Allocation of diesel agricultural equipment emissions to the municipality level were based on a 1990 INEGI census of operating tractors (INEGI, 1990a). Allocation of state-level construction equipment emissions was based on year 2000 municipality population, obtained from (INEGI, 200b)

6.3 Quality Assurance

Quality reviews were conducted during the development of the nonroad equipment inventory according to the QA Plan contained in the Mexico NEI Inventory Preparation Plan (ERG, 2003a). Specific QA checks were as follows:

- National agricultural diesel fuel consumption estimates were compared with predicted volumes for the Mexico equipment populations, using default hour per year values. Agreement was within 15 percent.
- The fraction of national agricultural emissions at the state level was compared to similar fractions for total crop acreage (SAGARPA, 2003). Of the border states, only Chihuahua differed by more than 2 percent in this comparison. It is recommended to evaluate specific crop types in this state to determine if higher or lower than average equipment utilization is required in this area.
- National-, state-, and municipality-level emission estimates were reviewed for reasonableness. Internal state- and municipality-level comparisons were conducted.
- Equipment populations and resulting emissions were compared with the employment ratios used as surrogates for reasonableness.
- Emissions for each state-level output were reviewed for reasonableness considering differences in temperature and altitude.

Table 6-3. Percent of Construction Workers Within the Six Northern States, 2000

State	Percent of Total Construction Workers in Mexico
Baja California	3.78%
Coahuila	3.50%
Chihuahua	3.65%
Nuevo León	7.09%
Sonora	4.17%
Tamaulipas	5.56%

6.4 Results by Source Category

Emissions for each nonroad source category (construction and agricultural), by state and pollutant, are provided in Appendix E. The overall results of the nonroad equipment emissions inventory for Mexico in 1999 are shown in Tables 6-4 and 6-5.

Table 6-4 shows that Tamaulipas has the largest emissions totals for all pollutants. While Tamaulipas ranks third in population among the border states, it contains by far the largest fraction of agricultural land, at 41 percent. Therefore, the combination of significant population (and therefore construction activity), and large amount of cropland (and therefore agricultural equipment) are consistent with this finding. Similarly, Coahuila and Baja California are both ranked low in population and crop acreage (two lowest among the six border states). As expected, these states also had the lowest nonroad equipment emission totals.

The table also shows that, in general, NO_x emissions are substantially higher than VOC emissions, primarily reflecting the importance of high power diesel equipment in the construction sector. And in relative terms, CO emissions are quite low, and PM quite high (for example, compared to on-road mobile sources), again due to the predominance of diesel over gasoline in the construction and agriculture sectors.

Table 6-5 shows that emissions from construction and agricultural equipment are roughly comparable. NO_x emissions are somewhat higher in the construction sector, again due to the relatively high power of the equipment compared to agricultural engines. VOC and CO emissions were relatively high in the construction sector, compared to other pollutants, due to the very low emissions of these pollutants from diesel agricultural equipment. (Recall that the construction equipment inventory estimated emissions for spark ignition as well as diesel engines, while the agricultural equipment inventory was limited to diesel engines.) For this same reason, PM emissions were actually higher for the agricultural sector.

6.4.1 Confidence Ratings

The confidence rating approach (as described in Section 2.3 of this report) was applied to each nonroad source category based upon the source of activity data and emission factor(s) used to develop the emissions estimates.

Table 6-4. 1999 Nonroad Emissions for Mexico, by State
Six Northern Mexican States (Final)

State Name	Annual Emissions (Mg/yr)					
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Aguascalientes						
Baja California	5,029.6	684.0	1,546.3	5,348.4	744.5	685.2
Baja California Sur						
Campeche						
Coahuila	4,783.8	655.2	1,437.8	5,054.4	714.3	657.2
Colima						
Chiapas						
Chihuahua	11,271.1	1,490.3	2,566.0	9,469.5	1,920.1	1,766.3
Distrito Federal						
Durango						
Guanajuato						
Guerrero						
Hidalgo						
Jalisco						
Mexico						
Michoacan						
Morelos						
Nayarit						
Nuevo Leon	8,202.8	1,128.6	2,660.1	9,257.8	1,166.7	1,073.5
Oaxaca						
Puebla						
Querétaro						
Quintana Roo						
San Luis Potosi						
Sinaloa						
Sonora	7,348.8	983.3	1,998.2	7,108.7	1,157.9	1,065.3
Tabasco						
Tamaulipas	14,683.7	1,909.1	3,465.9	12,827.6	2,453.1	2,256.9
Tlaxcala						
Veracruz						
Yucatán						
Zacatecas						
Border States	**51,319.9**	**6,850.5**	**13,674.2**	**49,066.4**	**8,156.7**	**7,504.5**
National						

Table 6-5. 1999 Nonroad Emissions for Mexico, by Category
Six Northern Mexican States (Final)

Nonroad Sources	Annual Emissions (Mg/yr)					
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Construction Equipment	28,414.9	3,947.5	9,839.2	33,680.4	3,877.7	3,567.5
Agricultural Equipment	22,905.0	2,903.0	3,835.0	15,386.0	4,279.0	3,937.0
Total from Nonroad Sources	51,319.9	6,850.5	13,674.2	49,066.4	8,156.7	7,504.5

For agricultural sources, activity data receives a B rating, given the extensive census of tractors and irrigation pumps available at the state level. Extrapolations to the municipality level are more uncertain given the age of the tractor census data (1990), and may merit adjustment for recent land use changes. The B rating is further justified based upon the close agreement between reported fuel consumption in this sector and that predicted using default hour per year data from the NONROAD2002 model. The overall rating might be improved to an A level if the equipment mix (beyond tractors and pumps) could be verified using local data.

For construction sources, activity data receives a D rating, since it is almost exclusively based on extrapolated U.S. data. However, state level employment statistics regarding construction workers should help in providing relatively accurate special allocation, at least at the state level. Significant improvements should be investigated for this sector using local data, especially considering the relatively high emissions rates compared to other nonroad source categories.

The confidence rating scheme presented above is not necessarily appropriate for rating emission factors for either agricultural or construction equipment. Although emission factors are based on adjusted U.S. estimates from the NONROAD model, we expect these estimates to be fairly robust. Combustion emissions from uncontrolled engines should have very similar emission rates, regardless of which countries the engines operate in. In addition, we would expect load factors to be similar as well, as these equipment are used in similar tasks in both countries. Potentially significant differences could arise from different hour per year utilization factors, or engine retirement rates (resulting in different lifetime deterioration rates.) However, given the uncertainties in other portions of the inventory, these differences are expected to be relatively minor. Although Mexico-specific emission factors are not explicitly contained in the NONROAD model, emission factors receive a C rating because of expected similarities in uncontrolled engines.

7.0 NATURAL SOURCES

Natural sources are those sources of air pollution that do not result from direct human activity. This section defines the natural source categories, describes the methods used to estimate emissions, explains how the data used to estimate natural source emissions were compiled, reviewed, and quality checked for the Mexico NEI. Emission estimates for the northern six states are summarized in this section, and detailed summaries by municipality included in Appendix F.

7.1 Source Categories

For purposes of the Mexico NEI, natural sources are defined as being either biogenic or geogenic. Biogenic sources include VOC emissions from forest or crops as well as soil NO_x emissions. Geogenic sources include emission sources that have a geologic origin such as volcanoes, geysers, sulfur springs, and oil seepage typically found in marine environments. Other insignificant natural sources such as lightening are not included in the Mexico NEI. Also, soil erosion caused by wind (i.e., windblown dust), which sometimes is considered to be a natural source, is not included in this section of the report, but is discussed in Section 4.0.

7.2 Methodology

The calculations to estimate biogenic VOC emissions involve multiplying an emission factor for a specific type of vegetation by the area of vegetation within the study domain. Other factors that affect the VOC emission rates include leaf area index, leaf temperature, and solar radiation within the vegetation canopy. In order to reflect the influence of these factors and develop VOC emission estimates quickly and efficiently, various biogenic computer models have been developed (primarily by the U.S. EPA). In addition to biogenic VOC, these models were also constructed to develop soil NO_x estimates. Soils emit NO_x primarily in the form of nitric oxide (NO). Emissions from soils are the result of natural microbial nitrogen processes.

For the Mexico NEI, the biogenic VOC emissions and soil NO_x emissions were estimated using a biogenic model developed by the Texas Commission on Environmental Quality (TCEQ). This model, the Global Biosphere Emission and Interactions System Version

3.1 (GloBEIS3), builds upon previous models developed by the U.S. EPA, and represents the most up-to-date biogenic emissions model that can be used on a personal computer. The GloBEIS3 program is written in Visual Basic and operates in a Microsoft Access framework (Yarwood et al., 2003). The GloBEIS3 computer model was used to develop biogenic emissions estimates in the Mexico NEI for isoprene (ISO), total monoterpenes (TMT), and other VOC species (OVOC), as well as NO estimates from soil microbial activity. GloBEIS provides hourly VOC and NO_x emission estimates for each municipality contained within the inventory domain.

7.2.1 Data Collection

In order to use GloBEIS, three datasets need to be developed: (1) domain definitions; (2) meteorological data; and (3) land use data. Data collection and compilation of these three data sets is described below. Other data inputs used to run the GloBEIS model included time zone, start and end hour and day, and base year (1999). In addition, two defaults in GloBEIS model were used unchanged: number of canopy layers (5 layers), and isoprene emission factor (1 factor).

Domain Definition

The domain definition data set defines the general spatial attributes needed for GloBEIS for each municipality. Specifically, the following input data were compiled:

- The state code;
- The municipality code;
- The latitude and longitude coordinates for each municipality's centroid; and
- The area in square kilometers [km^2] of the municipality.

One of the problems encountered in developing the domain definition data set concerned the addition of several new municipalities. Some of the data provided for the land use data files used an older data set which had fewer municipalities and did not agree with a more recent GIS shape file of the municipalities. To resolve this problem, the land use data were "mapped" to the most recent GIS shape file of municipalities.

Meteorological data

The GloBEIS model allows the user to enter a variety of optional types of meteorological data (e.g., wind speed, humidity, antecedent temperature, and drought index). These input data are primarily used for research purposes and are often not readily available. Currently it is not clear how to interpret emission estimates developed with these optional data (Estes, 2002). Therefore, these optional data were not used for the Mexico NEI. The meteorological data developed for this inventory comprise two separate data files: hourly cloud coverage and temperature.

The cloud cover data are provided as a fraction of clear sky and total cloud cover. For example, a clear day would have a cloud coverage fraction of 0.00 (or 0 percent) while a period with thick cloud coverage would have a fraction of 1.00 (or 100 percent). Cloud cover data for this project were provided directly by the Mexican National Weather Service (Servicio Meteorológico Nacional - SMN) (SMN 2003). Of the 147 meteorological sites that were included in the SMN data set, only 40 percent of the sites had hourly values for cloud cover for the entire year. Each municipality was assigned cloud coverage data from the closest meteorological site by overlaying the Mexico meteorological stations onto a municipality map; municipalities with no reporting meteorological station within their boundaries were assigned the station nearest to them. Figure 7-1 shows the meteorological stations that provided hourly cloud cover data.

Approximately 10 percent of the hourly temperature values provided by SMN were complete. The U.S. National Climatic Data Center (NCDC) compiles hourly temperature data for Mexican weather stations (NCDC, 2003). The SMN collects the data, and provides it to NCDC, where it is compiled and released to the public. The NCDC database consists of hourly temperatures for a total of 116 sites in the country of Mexico. The NCDC hourly temperature values were used to fill the data gaps in the SMN data set. Data gaps in the NCDC data were supplemented with new hourly temperature data developed by using temperature rate change profiles for the individual sites. As with the cloud cover data, temperature data were assigned to individual municipalities based on the proximity of the meteorological stations by overlaying the Mexico meteorological stations onto a municipality map. Municipalities with no reporting station

Figure 7-1. Location of Meteorological Stations in Mexico with Hourly Cloud Cover Data

were assigned the station nearest to them. Figure 7-2 shows the location of the meteorological stations that provided hourly temperature data. It should be noted that that the meteorological stations with cloud cover data do not necessarily correspond with stations that provided temperature data.

Land Use Data

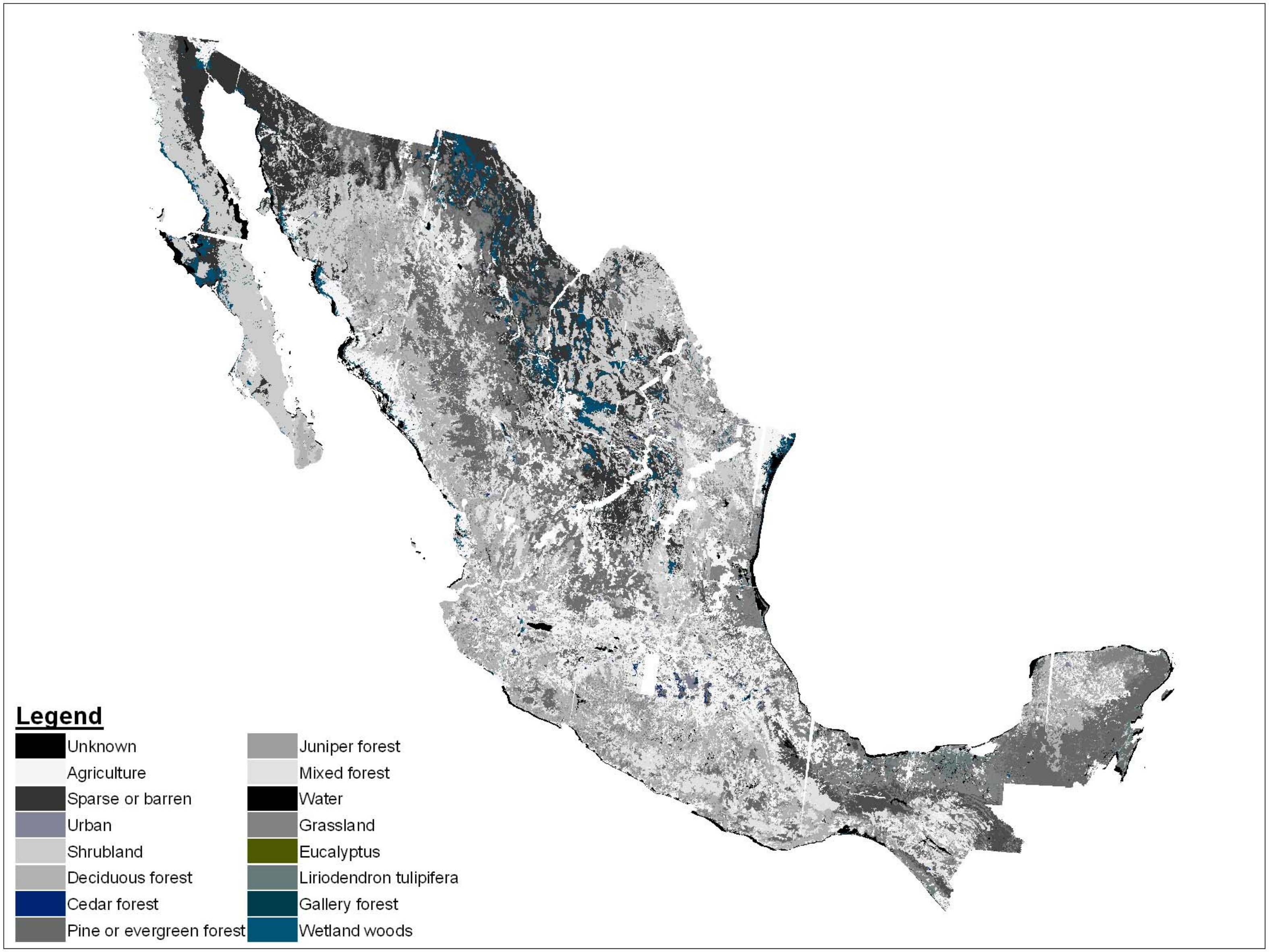
As with meteorological data, the GloBEIS model allows the user to enter a variety of optional types of vegetative plant data (e.g., number of canopy layers, leaf area index, leaf age, and leaf temperature). However, many of these data are not readily available at the national level, and furthermore, it is unclear how to interpret emission estimates made with these optional data (Estes, 2002). Therefore, these optional data were not used for the Mexico NEI.

This land use data set was compiled using information from the 2000–2001 National Forestry Inventory for Mexico (UNAM, 2002). These data were provided as GIS shape files that quantified the location of different forestry species. Unfortunately, the shape files did not match the state or municipality shape files, so each state had to be aligned to match the municipality boundary data associated with the domain definitions. It should be noted that the aligned data set is not perfectly aligned (i.e., a few data gaps still remain). However, these are not considered significant. Forestry species were mapped to the emission factors in GloBEIS. Species that could not be mapped to specific or similar species in GloBEIS were classified as "Mixed Forest". The map in Figure 7-3 shows the final land use data set developed for this project.

Data similar to that provided for forestry activities were not available to represent agricultural practices. Agricultural statistics were obtained from SAGARPA (SAGARPA, 2003). These statistics quantified the types of crops planted at the state level and included hectares planted for over 300 different crop types. These individual crops were then mapped to the available emission factors within the GloBEIS model. State level data were applied to each municipality in the state. In some cases, the SAGARPA crop information was more specific than the available emission factors. Crop types that could not be mapped to specific or similar species in GloBEIS were mapped as "Miscellaneous Crops." However, in some cases, a crop that did not have a specific emission factor was one of the most widely planted crops in a state

Figure 7-2. Location of Meteorological Stations in Mexico with Hourly Temperature Data

Figure 7-3. Land Use Data Set Developed for the Mexico NEI



mapped to tobacco, because all three are in the *Solanaceae* family. These assignments are consistent with the expected emission levels for these crops (Geron, 2003).

7.2.2 Calculation of Emissions

All of the data input files were compiled into the required GloBEIS format. Additional details on GloBEIS and the input file format are contained in the Natural Source Manual of the Mexico Emissions Inventory Program Manual series (ERG, 2002a). The GloBEIS model runs were made as batch runs for each state. The output data were compiled into Microsoft Access data tables for quality assurance checks and to generate the final summary tables.

7.2.3 Quality Assurance

Quality reviews were conducted throughout the development of the natural source inventory according to the QA Plan contained in the Mexico NEI Inventory Preparation Plan (ERG, 2003a). Specific QA checks were as follows:

- Data gathered as model inputs for the GloBEIS model for each municipality (i.e., total area covered, and latitude/longitude coordinates of the centroid), land cover type, and vegetation coverage, were checked for completeness and correctness. Code assignments were reviewed for correctness. For land cover type and vegetation coverage, these codes mapped directly to the NO_x and VOC emission factors. Other data for temperature and cloud cover were reviewed to verify that the data extrapolated to each municipality was reasonable.

- The GloBEIS model also includes a QA inputs module that verifies that the input data are consistent with one another. For example, the QA module verifies that there are land use data for every land use code, and that there are cloud cover and temperature data for every cell and every hour. This module was employed to ensure input file completeness.

- The final QA step was to closely review the GloBEIS summary reports to make sure the results corresponded to the land use types. For example, a municipality which had the land used code of "urban" would be expected to have lower NO_x emissions than one that is coded as "cropland".

All errors that were found were corrected before proceeding with subsequent steps to run the GloBEIS model and estimate natural source emissions for the Mexico NEI.

7.3 Results by VOC Species

Table 7-1 shows the results of the natural (biogenic) emissions inventory by state for the six northern Mexican states. These results show that VOC emissions from forests are proportional to the size of each state, with the larger states, such as Chihuahua having higher total VOC emissions than smaller states. The NO_x emission estimates correlate well with a state's agricultural activities, which is reasonable as most biogenic NO_x emissions are associated with fertilizer usage. For example, the state of Tamaulipas has considerable agricultural activities in the coastal plains, and in the southern basin of the Rio Grande River. Such activities are reflected in the fact that Tamaulipas, although it is a relatively small state geographically speaking, has the highest biogenic NO_x emissions. Alternatively, there is relatively little agricultural activity in Baja California resulting in relatively low biogenic NO_x emissions from soils.

7.3.1 Data Limitations

The GloBEIS model is an efficient tool for estimating biogenic emissions, and allows the user significant flexibility in the types of data they use to estimate these emissions. For the Mexico NEI, there were certain data limitations that effect the types of data that could be input, and the results generated by the GloBEIS model:

- The first data limitation is related to the seasonality of the crop data. Although GloBEIS allows the user to define crop coverages on an hourly basis for the year, this level of temporal resolution could not be identified for the crop coverages in Mexico. Therefore, an assumption of year-round crop coverage was made. Thus, the soil NO_x emissions are likely over-estimated due to this simplifying assumption.

- The second data limitation is related to how data gaps in the cloud cover and temperature data were filled. Cloud cover averages were developed that assumed a higher number of clear days (0 cloud coverage data), such that emissions would be increased due to increased in photosynthesis. Also, the temperature rate changes that were developed may be higher than actual rate changes. Both of these limitations would cause estimated VOC emissions to be greater than actual emissions.

- The third data limitation is related to the land use data set that was used (UNAM, 2002). Actual urban areas in Mexico are probably larger than what is reported in the land use data set. Urban land areas are associated with decreased forestry activities. Also, in some cases the land codes

Table 7-1. 1999 Natural Emissions for Mexico, by State
Six Northern Mexican States (Final)

State Name	Annual Emissions (Mg/year)				
	NO_x	Isoprene	Monoterpenes	Other VOCs	Total VOCs
Aguascalientes					
Baja California	4,452.8	2,568.9	8,354.8	7,720.8	18,644.6
Baja California Sur					
Campeche					
Coahuila	62,081.1	112,566.1	118,264.6	145,243.0	376,073.7
Colima					
Chiapas					
Chihuahua	51,705.5	878,643.8	467,149.9	580,800.2	1,926,593.9
Distrito Federal					
Durango					
Guanajuato					
Guerrero					
Hidalgo					
Jalísco					
México					
Michoacán					
Morelos					
Nayarit					
Nuevo León	39,016.4	100,952.5	78,576.9	85,964.8	265,494.1
Oaxaca					
Puebla					
Querétaro					
Quintana Roo					
San Luis Potosí					
Sinaloa					
Sonora	56,601.9	408,800.6	130,932.4	248,355.3	788,088.4
Tabasco					
Tamaulipas	79,399.9	265,309.9	76,828.5	124,205.8	466,344.3
Tlaxcala					
Veracruz					
Yucatán					
Zacatecas					
Border States	**293,257.6**	**1,768,841.8**	**880,107.3**	**1,192,289.9**	**3,841,239.0**
National					

indicated mixed vegetation with specific forest types. However, the actual species associated with the mixed vegetation (i.e., bush and shrub species that have lower VOC emissions that some forest vegetation) and the extent of their growth relative to the coincident forest species was not known; therefore, it was necessary to use the forest species, only, for those mixed vegetation land use types. Both of these limitations (i.e., potentially underestimated urban areas, and overestimate forest species) would cause estimated VOC emissions to be greater than actual emissions.

As more meteorological data become available, specifically hourly temperature data, the natural source emissions inventory should be updated. Also, the forestry emission factors should be reviewed in the future and new emission factor data for species currently not in GloBEIS should be added to provide a more complete and comprehensive emission inventory. Finally, comprehensive agricultural data are needed at the municipality level to quantify what crops are grown, and their growing season. Currently, only state-level data are available for hectares grown by crop.

8.0 ANALYSIS OF RESULTS

The Mexico NEI inventory currently contains emissions estimates for point, area, motor vehicle, nonroad, and natural sources within the six northern states for the year 1999. This section examines the overall border states inventory and discusses the relative contribution of sources to the inventory, as well as the state totals by pollutant.

8.1 Discussion of Results

A summary of the 1999 Mexico NEI for the six northern states is shown in Table 8-1, both in terms of Mg/year and percentage contributed by source category. Table 8-1a shows how the source categories comprising the various source types (i.e., point, area, motor vehicles, nonroad, and natural) are aggregated for purposes of summarizing the inventory in Table 8-1. The following observations can be made regarding the six state inventory summary:

- Natural sources are the most significant source of NO_x and VOC emissions. However, as noted in Section 7.0 of this report, there are several factors contributing to the likely overestimate of the natural source emissions.

- After natural sources, utilities are the next major contributor of NO_x, followed by on-road and nonroad motor vehicles. Utilities, on-road and nonroad motor vehicles emit approximately 42 percent of the total NO_x inventory (i.e., approximately 289,500 Mg/year), or over 73 percent of the total inventory minus the natural source emissions.

- Utilities, followed by petroleum and coal product manufacturing (i.e., refineries), manufacturing and other industrial processes, and industrial fuel combustion (an area source) emit approximately 97% of the total SO_x inventory (i.e., approximately 689,000 Mg/year).

- After natural sources, solvent utilization, on-road motor vehicles, and fuel distribution (i.e., gasoline and LPG) are the next major VOC emitters. These three categories emit only approximately 9 percent of the total VOC inventory (i.e., approximately 389,700 Mg/year), or over 76 percent of the total inventory minus the natural source emissions.

- CO emissions are mainly from motor vehicles with over 72 percent of the total CO inventory, followed by other fuel combustion (i.e., mainly LPG in the transportation sector) with approximately 10 percent of the total CO inventory.

Table 8-1. 1999 Mexico National Emissions Inventory[a] Six Northern Mexican States (Final)

Source Category	Emissions (1,000 Mg/year)						
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Mining	1.8	6.9	0.1	8.4	21.2	6.3	
Utilities	143.5	500.0	1.1	9.1	24.4	23.9	
Petroleum and Coal Products Manufacturing	8.3	71.7	42.8	15.0	4.5	2.9	
Manufacturing and Other Industrial Processes	31.7	59.0	24.3	34.0	27.9	23.6	
Industrial Fuel Combustion	17.3	58.3	2.6	6.4	6.6	4.7	0.1
Other Fuel Combustion	15.9	0.1	20.0	120.9	8.3	8.0	
Fuel Distribution			90.7				
Solvent Utilization			184.8				
Fires/Burning	1.0	0.1	7.5	76.5	11.6	10.8	
Fugitive Dust					718.6	131.8	
Ammonia Sources							187.4
Other Area Sources	28.7	0.4	18.1	28.7	2.0	1.7	
On-Road Motor Vehicles	94.7	5.3	118.2	916.4	2.7	2.2	1.6
Nonroad Mobile Sources	51.3	6.9	13.7	49.1	8.2	7.5	
Natural Sources	293.3		3,841.2				
Total[a]	**687.3**	**708.6**	**4,365.1**	**1,264.5**	**835.9**	**223.4**	**189.0**

Source Category	Emissions (Percent)						
	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Mining	0.26	0.97	0.00	0.66	2.54	2.84	
Utilities	20.87	70.57	0.03	0.72	2.92	10.71	
Petroleum and Coal Products Manufacturing	1.20	10.12	0.98	1.18	0.53	1.30	
Manufacturing and Other Industrial Processes	4.62	8.32	0.56	2.69	3.34	10.58	
Industrial Fuel Combustion	2.51	8.22	0.06	0.51	0.79	2.09	0.04
Other Fuel Combustion	2.32	0.02	0.46	9.56	0.99	3.56	
Fuel Distribution			2.08				
Solvent Utilization			4.23				
Fires/Burning	0.14	0.02	0.17	6.05	1.39	4.84	
Fugitive Dust					85.97	58.97	
Ammonia Sources							99.11
Other Area Sources	4.17	0.05	0.42	2.27	0.24	0.76	0.00
On-Road Motor Vehicles	13.78	0.74	2.71	72.47	0.33	1.01	0.84
Nonroad Mobile Sources	7.47	0.97	0.31	3.88	0.98	3.36	
Natural Sources	42.67		88.00				
Total[a]	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

[a] Total may not equal sum of category emissions due to rounding.

Table 8-1a. Listing of Mexico NEI Aggregated Source Categories for Table 8-1

Source	Mexico NEI Source Category	Aggregated Source Category on Table 8-1
Point	Mining (except oil & gas)	Mining
	Utilities	Utilities
	Petroleum and Coal Product Manufacturing	Petroleum and Coal Product Manufacturing
	Food Manufacturing	Manufacturing and Other Industrial Processes
	Beverage & Tobacco Product Manufacturing	Manufacturing and Other Industrial Processes
	Apparel Manufacturing	Manufacturing and Other Industrial Processes
	Wood Product Manufacturing	Manufacturing and Other Industrial Processes
	Paper Manufacturing	Manufacturing and Other Industrial Processes
	Chemical Manufacturing	Manufacturing and Other Industrial Processes
	Plastics & Rubber Products Manufacturing	Manufacturing and Other Industrial Processes
	Nonmetallic Mineral Manufacturing	Manufacturing and Other Industrial Processes
	Primary Metal Manufacturing	Manufacturing and Other Industrial Processes
	Fabricated Metal Product Manufacturing	Manufacturing and Other Industrial Processes
	Machinery Manufacturing	Manufacturing and Other Industrial Processes
	Computer & Electronic Product Manufacturing	Manufacturing and Other Industrial Processes
	Electrical Equipment, Appliance & Component Manufacturing	Manufacturing and Other Industrial Processes
	Transportation Equipment Manufacturing	Manufacturing and Other Industrial Processes
	Furniture & Related Product Manufacturing	Manufacturing and Other Industrial Processes
	Miscellaneous Manufacturing	Manufacturing and Other Industrial Processes
	Other Manufacturing	Manufacturing and Other Industrial Processes
	Merchant Wholesalers, Nondurable Goods	Manufacturing and Other Industrial Processes
	Waste Management and Remediation Services	Manufacturing and Other Industrial Processes
Area	Distillate – Fuel Combustion – Industrial	Industrial Fuel Combustion
	Distillate Fuel Combustion – Commercial	Industrial Fuel Combustion
	Residual- Fuel combustion-Industrial	Industrial Fuel Combustion
	Residual- Fuel combustion-Commercial	Industrial Fuel Combustion
	LPG- Fuel combustion-Industrial	Industrial Fuel Combustion
	LPG- Fuel combustion-Commercial	Industrial Fuel Combustion

Table 8-1a. Cont.

Source	Mexico NEI Source Category	Aggregated Source Category on Table 8-1
Area Cont.	LPG- Fuel combustion-Residential	Other Fuel Combustion
	LPG- Fuel combustion-Agricultural	Other Fuel Combustion
	LPG- Fuel combustion-Transportation	Other Fuel Combustion
	Natural Gas- Fuel combustion-Industrial	Industrial Fuel Combustion
	Natural Gas- Fuel combustion-Commercial	Industrial Fuel Combustion
	Natural Gas- Fuel combustion-Residential	Other Fuel Combustion
	Kerosene- Fuel combustion-Industrial	Industrial Fuel Combustion
	Kerosene- Fuel combustion-Residential	Other Fuel Combustion
	Kerosene- Fuel combustion-Agricultural	Other Fuel Combustion
	Wood- Fuel combustion	Other Fuel Combustion
	Coke-Fuel combustion	Industrial Fuel Combustion
	Bagasse- Fuel combustion	Industrial Fuel Combustion
	Locomotives	Other Area Sources
	Aircraft	Other Area Sources
	Commercial marine vessels	Other Area Sources
	Border crossings	Other Area Sources
	Gasoline distribution	Fuel Distribution
	LPG distribution	Fuel Distribution
	Industrial surface coatings	Solvent Utilization
	Degreasing	Solvent Utilization
	Architectural surface coatings	Solvent Utilization
	Autobody refinishing	Solvent Utilization
	Consumer solvent usage	Solvent Utilization
	Dry cleaning	Solvent Utilization
	Graphic arts	Solvent Utilization
	Traffic markings	Solvent Utilization
	Asphalt application	Solvent Utilization
	Bakeries	Other Area Sources
	Wastewater treatment	Other Area Sources
	Agricultural tilling	Fugitive Dust

Table 8-1a. Cont.

Source	Mexico NEI Source Category	Aggregated Source Category on Table 8-1
Area Cont.	Agricultural burning	Fires/Burning
	Livestock ammonia	Ammonia Sources
	Fertilizer application	Ammonia Sources
	Pesticide application	Solvent Utilization
	Beef cattle feedlots	Fugitive Dust
	Brick kilns	Industrial Fuel Combustion
	Charbroiling/Street vendors	Other Area Sources
	Open burning – Waste	Fires/Burning
	Wildfires	Fires/Burning
	Structure fires	Fires/Burning
	Construction activities	Fugitive Dust
	Paved road dust	Fugitive Dust
	Unpaved road dust	Fugitive Dust
	Domestic ammonia	Ammonia Sources
Motor Vehicles	All	On-road Motor Vehicles
Nonroad Mobile Sources	All	Nonroad Mobile Sources
Natural	All	Natural Sources

- PM_{10} and $PM_{2.5}$ emissions are mainly from fugitive dust (i.e., paved and unpaved road dust reentrainment) which contribute over 85 percent of the total PM_{10} inventory and 58 percent of the total $PM_{2.5}$ inventory. After fugitive dust, manufacturing and other processes, and utilities emit the most PM_{10} and $PM_{2.5}$ emissions. These two categories emit only approximately 6 percent of the total PM_{10} inventory and approximately 22 percent of the total $PM_{2.5}$ inventory.

- Livestock and domestic generation of NH_3 along with fertilizer application are responsible for the majority of the NH_3 emissions within the six northern states. Only minor contributions come from industrial fuel combustion and motor vehicles.

Figures 8-1 through 8-7 show the 1999 Mexico NEI results for the individual pollutants, and compare the magnitude of these pollutants among the six northern states. The Mexico NEI results are shown on the state level in Appendix G and on the municipality level in Appendix H. Note that the emissions shown on Figures 8-1 through 8-7 *do not* include natural sources due to the overall high level of uncertainty in those emissions.

The following observations can be made regarding these summaries shown by Figures 8-1 through 8-7:

- Sources in Coahuila (mainly carboelectric power plants) generate the most NO_x emissions compared to other states.

- SO_x emissions in Sonora, Coahuila, and Tamaulipas are highest mainly from power plants located in these states.

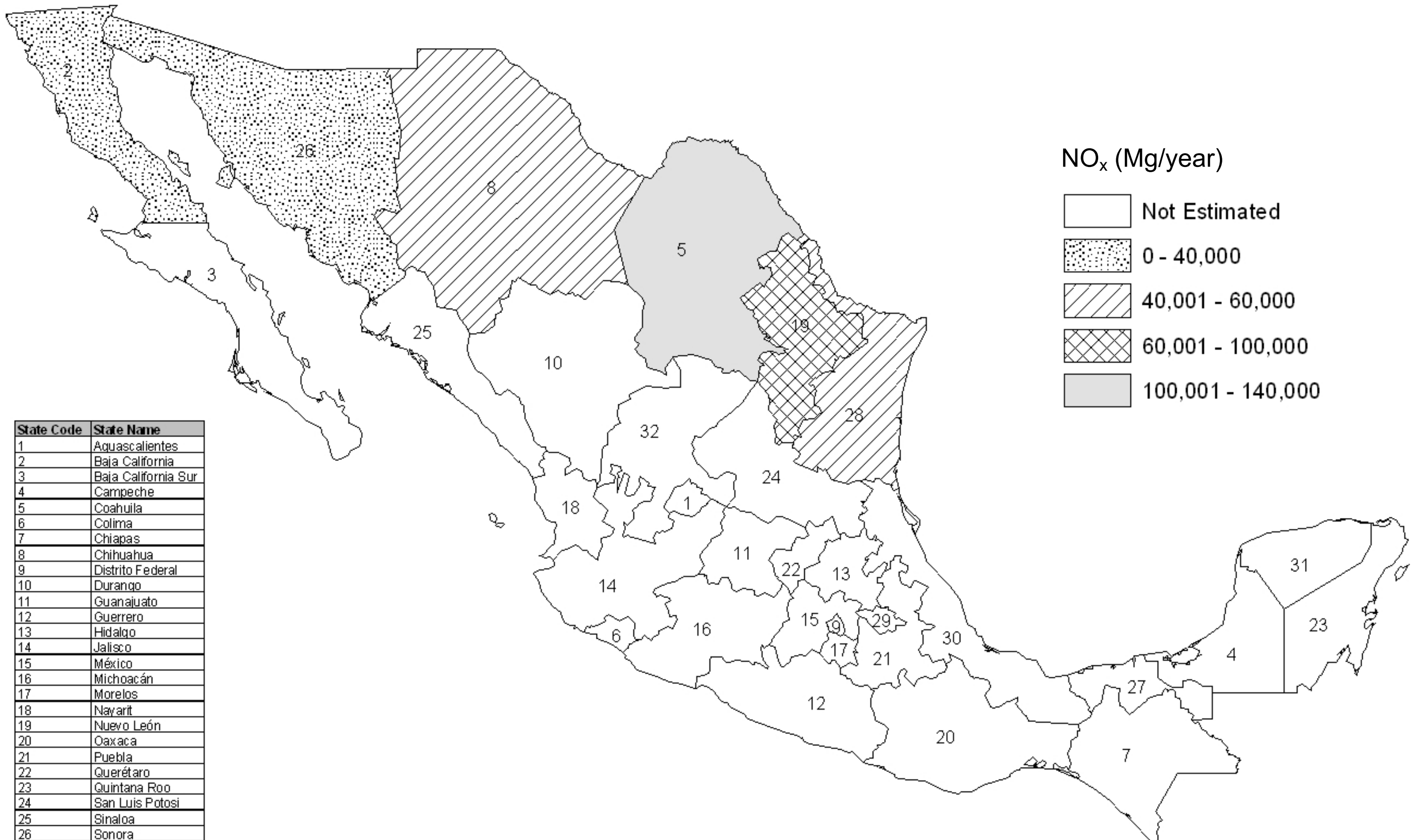
- VOC emissions from various area sources located in Nuevo León are significant compared to other states.

- Nuevo León generates the most CO emissions (primarily from motor vehicles, and due to relatively high VKT).

- Nuevo León generates the most PM_{10} and $PM_{2.5}$ emissions (mainly paved and unpaved road dust reentrainment). Also, Chihuahua also has relatively high PM_{10} emissions mainly due to paved and unpaved road dust reentrainment.

- Sonora's livestock population is responsible for that state's relatively high NH_3 emissions.

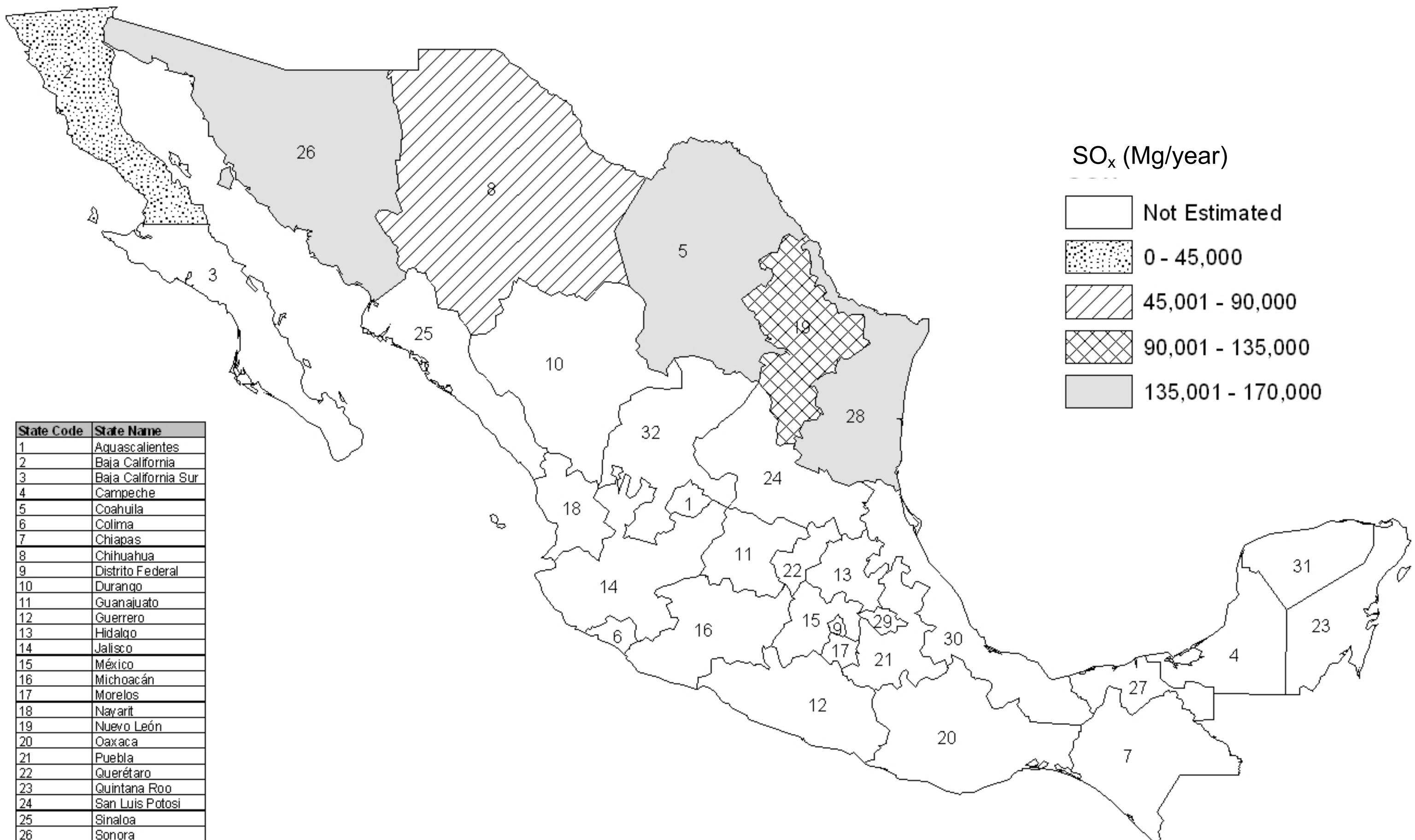
Figure 8-1. 1999 NO_x Emissions for Mexico[a] Six Northern Mexican States (Final)



State Code	State Name
1	Aguascalientes
2	Baja California
3	Baja California Sur
4	Campeche
5	Coahuila
6	Colima
7	Chiapas
8	Chihuahua
9	Distrito Federal
10	Durango
11	Guanajuato
12	Guerrero
13	Hidalgo
14	Jalisco
15	México
16	Michoacán
17	Morelos
18	Nayarit
19	Nuevo León
20	Oaxaca
21	Puebla
22	Querétaro
23	Quintana Roo
24	San Luis Potosi
25	Sinaloa
26	Sonora
27	Tabasco
28	Tamaulipas
29	Tlaxcala
30	Veracruz
31	Yucatán
32	Zacatecas

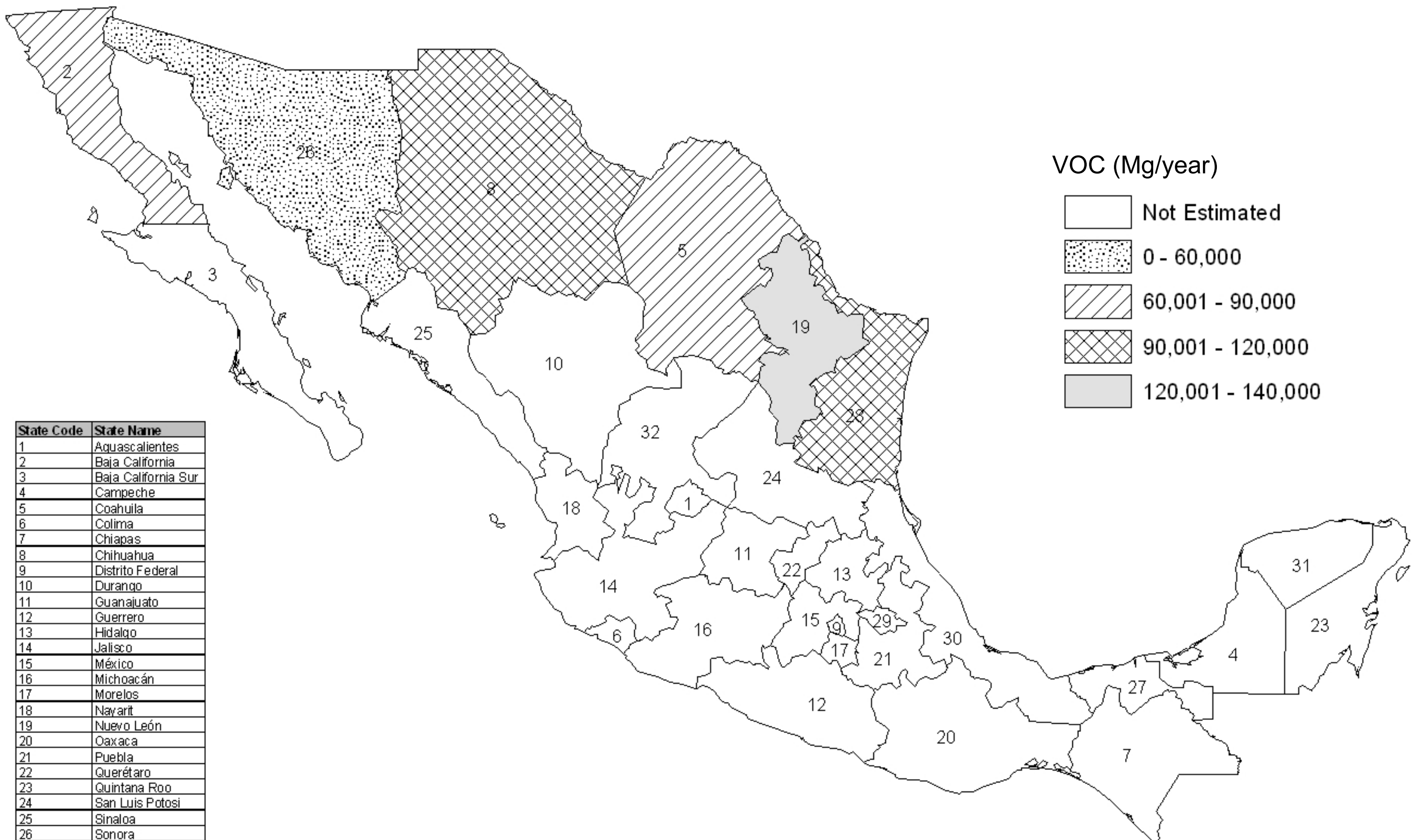
[a] Emissions include point, area, on-road motor vehicle, and nonroad sources. Natural sources are not included on this map.

Figure 8-2. 1999 SO_x Emissions for Mexico Six Northern Mexican States (Final)



State Code	State Name
1	Aguascalientes
2	Baja California
3	Baja California Sur
4	Campeche
5	Coahuila
6	Colima
7	Chiapas
8	Chihuahua
9	Distrito Federal
10	Durango
11	Guanajuato
12	Guerrero
13	Hidalgo
14	Jalisco
15	México
16	Michoacán
17	Morelos
18	Nayarit
19	Nuevo León
20	Oaxaca
21	Puebla
22	Querétaro
23	Quintana Roo
24	San Luis Potosi
25	Sinaloa
26	Sonora
27	Tabasco
28	Tamaulipas
29	Tlaxcala
30	Veracruz
31	Yucatán
32	Zacatecas

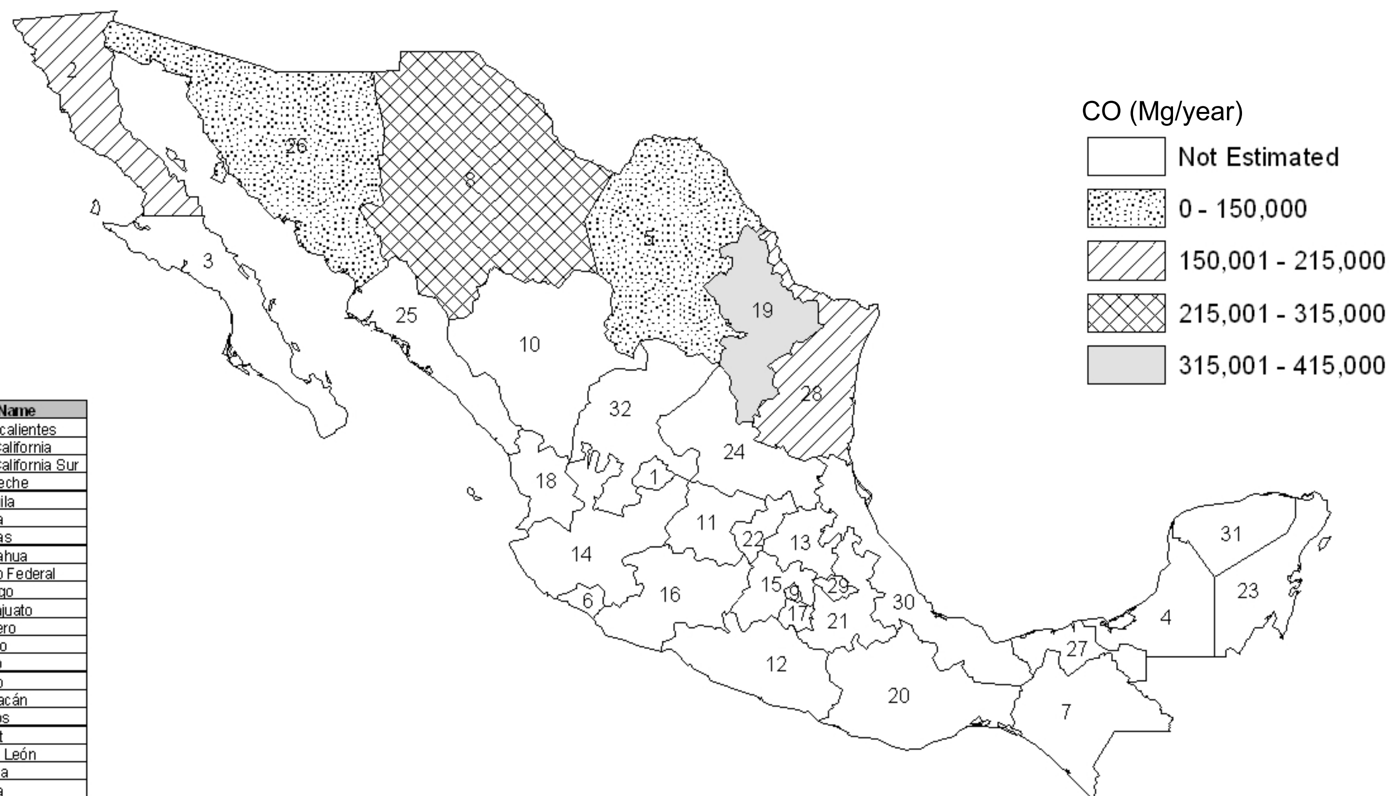
Figure 8-3. 1999 VOC Emissions for Mexico[a] Six Northern Mexican States (Final)



State Code	State Name
1	Aguascalientes
2	Baja California
3	Baja California Sur
4	Campeche
5	Coahuila
6	Colima
7	Chiapas
8	Chihuahua
9	Distrito Federal
10	Durango
11	Guanajuato
12	Guerrero
13	Hidalgo
14	Jalisco
15	México
16	Michoacán
17	Morelos
18	Nayarit
19	Nuevo León
20	Oaxaca
21	Puebla
22	Querétaro
23	Quintana Roo
24	San Luis Potosi
25	Sinaloa
26	Sonora
27	Tabasco
28	Tamaulipas
29	Tlaxcala
30	Veracruz
31	Yucatán
32	Zacatecas

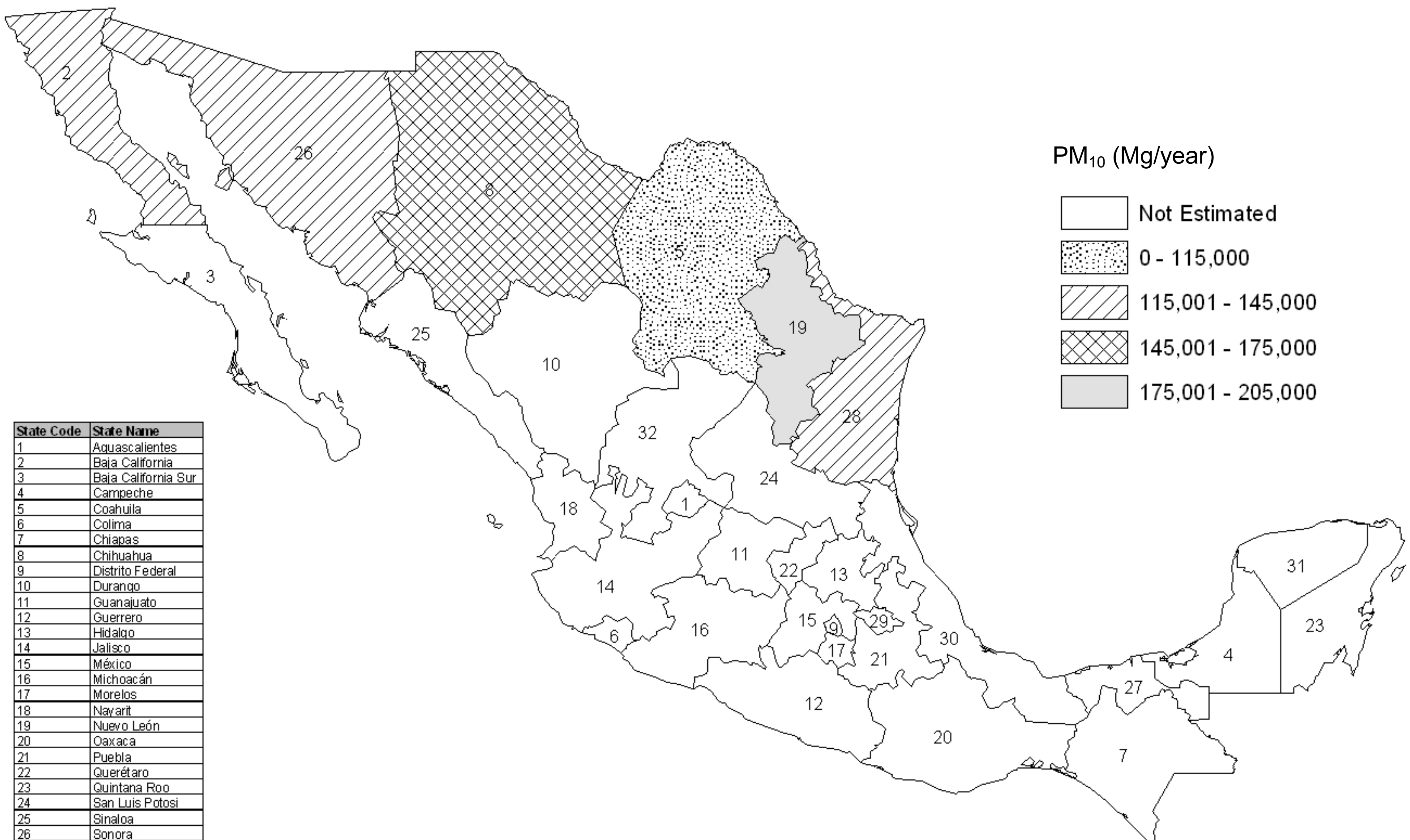
[a] Emissions include point, area, on-road motor vehicle, and nonroad sources. Natural sources are not included on this map.

Figure 8-4. 1999 CO Emissions for Mexico
Six Northern Mexican States (Final)



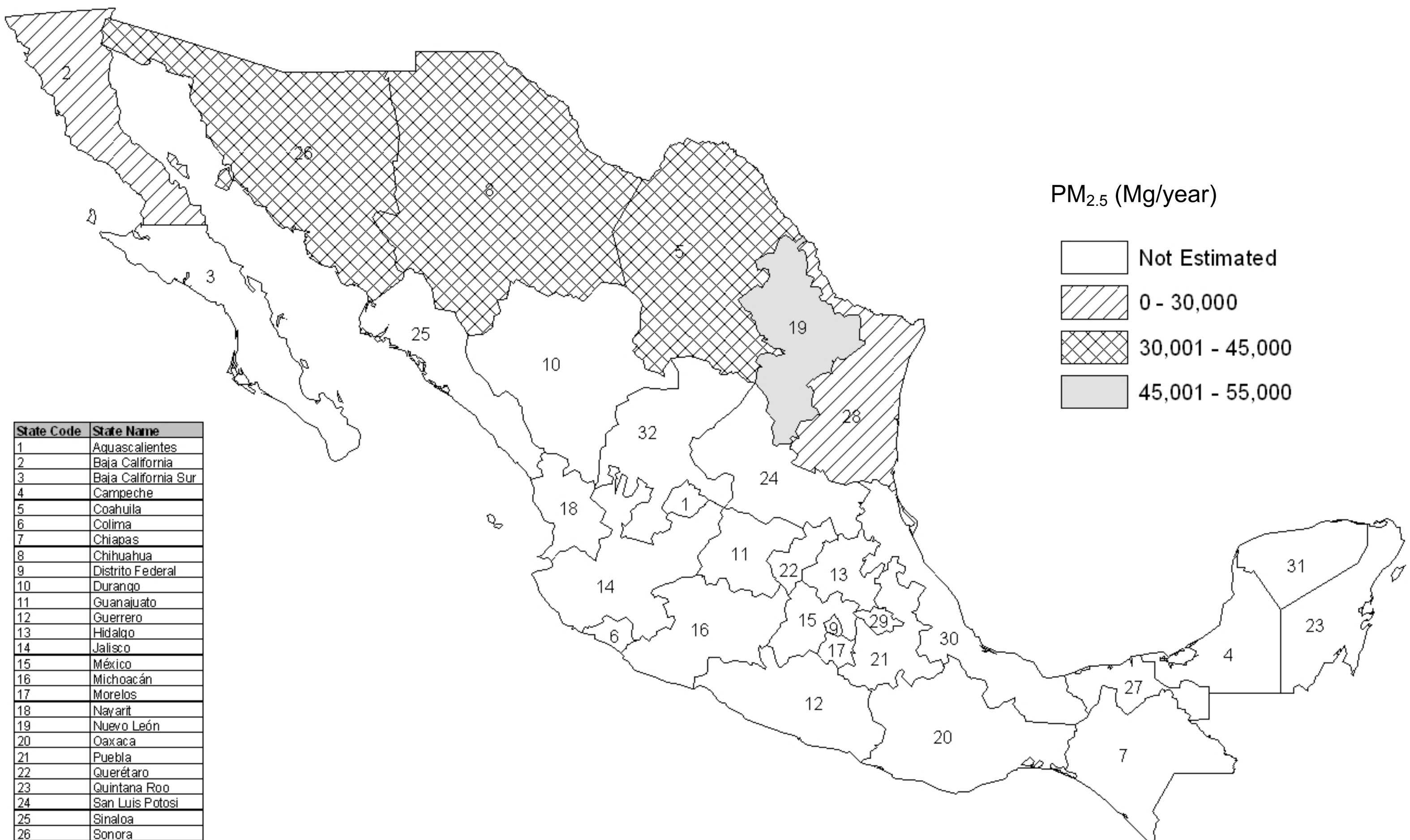
State Code	State Name
1	Aguascalientes
2	Baja California
3	Baja California Sur
4	Campeche
5	Coahuila
6	Colima
7	Chiapas
8	Chihuahua
9	Distrito Federal
10	Durango
11	Guanajuato
12	Guerrero
13	Hidalgo
14	Jalisco
15	México
16	Michoacán
17	Morelos
18	Nayarit
19	Nuevo León
20	Oaxaca
21	Puebla
22	Querétaro
23	Quintana Roo
24	San Luis Potosi
25	Sinaloa
26	Sonora
27	Tabasco
28	Tamaulipas
29	Tlaxcala
30	Veracruz
31	Yucatán
32	Zacatecas

Figure 8-5. 1999 PM_{10} Emissions for Mexico
Six Northern Mexican States (Final)



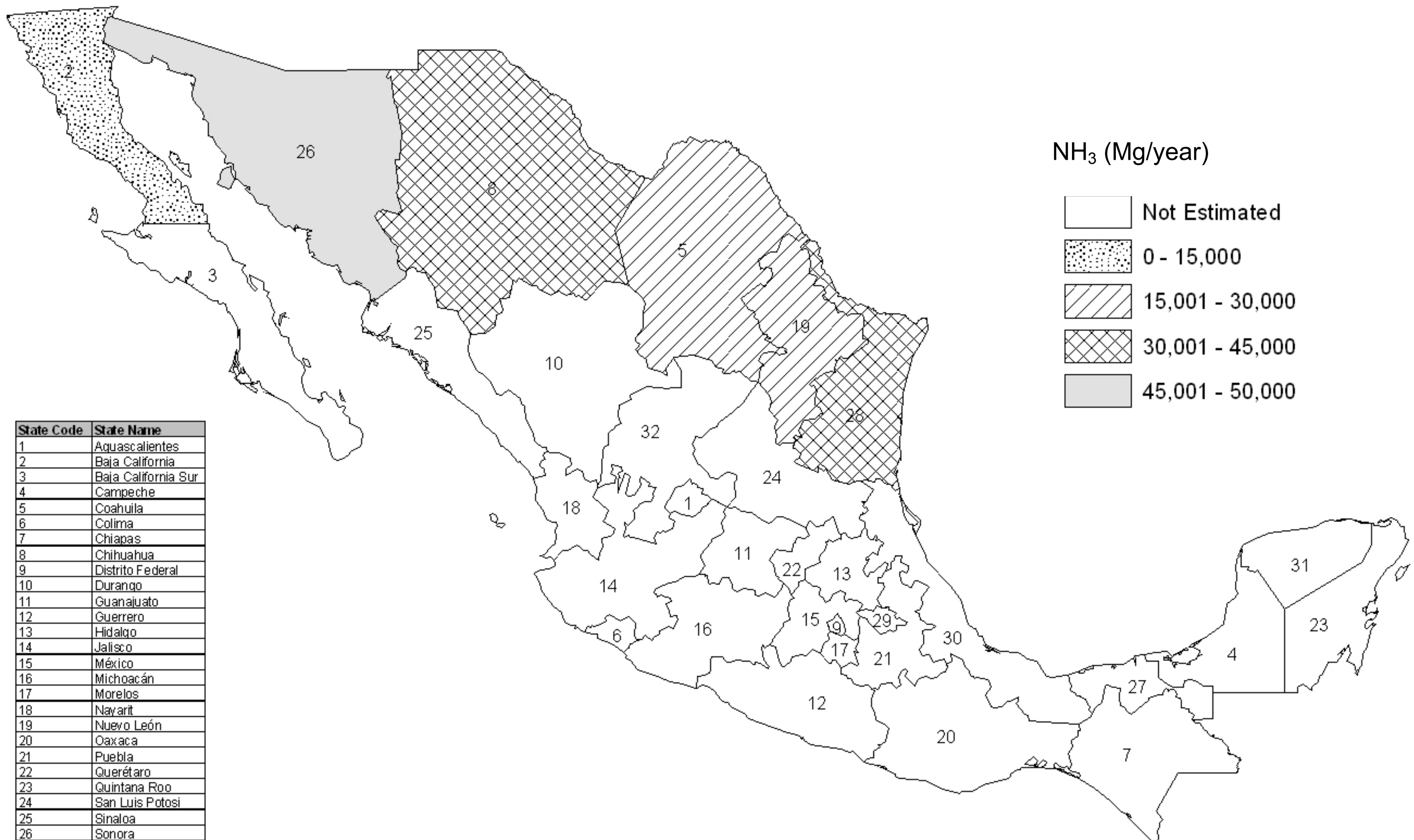
State Code	State Name
1	Aguascalientes
2	Baja California
3	Baja California Sur
4	Campeche
5	Coahuila
6	Colima
7	Chiapas
8	Chihuahua
9	Distrito Federal
10	Durango
11	Guanajuato
12	Guerrero
13	Hidalgo
14	Jalisco
15	México
16	Michoacán
17	Morelos
18	Nayarit
19	Nuevo León
20	Oaxaca
21	Puebla
22	Querétaro
23	Quintana Roo
24	San Luis Potosi
25	Sinaloa
26	Sonora
27	Tabasco
28	Tamaulipas
29	Tlaxcala
30	Veracruz
31	Yucatán
32	Zacatecas

Figure 8-6. 1999 $PM_{2.5}$ Emissions for Mexico Six Northern Mexican States (Final)



State Code	State Name
1	Aguascalientes
2	Baja California
3	Baja California Sur
4	Campeche
5	Coahuila
6	Colima
7	Chiapas
8	Chihuahua
9	Distrito Federal
10	Durango
11	Guanajuato
12	Guerrero
13	Hidalgo
14	Jalisco
15	México
16	Michoacán
17	Morelos
18	Nayarit
19	Nuevo León
20	Oaxaca
21	Puebla
22	Querétaro
23	Quintana Roo
24	San Luis Potosi
25	Sinaloa
26	Sonora
27	Tabasco
28	Tamaulipas
29	Tlaxcala
30	Veracruz
31	Yucatán
32	Zacatecas

Figure 8-7. 1999 NH_3 Emissions for Mexico Six Northern States (Final)



State Code	State Name
1	Aguascalientes
2	Baja California
3	Baja California Sur
4	Campeche
5	Coahuila
6	Colima
7	Chiapas
8	Chihuahua
9	Distrito Federal
10	Durango
11	Guanajuato
12	Guerrero
13	Hidalgo
14	Jalisco
15	México
16	Michoacán
17	Morelos
18	Nayarit
19	Nuevo León
20	Oaxaca
21	Puebla
22	Querétaro
23	Quintana Roo
24	San Luis Potosi
25	Sinaloa
26	Sonora
27	Tabasco
28	Tamaulipas
29	Tlaxcala
30	Veracruz
31	Yucatán
32	Zacatecas

8.2 Conclusions and Recommendations

The Mexico NEI is the first national emissions inventory for the country of Mexico. This inventory represents a significant effort by many public and private entities, including Mexican and U.S. federal and state environmental agencies located along both sides of the Mexico/U.S. border, as well as in Mexico City, and other Mexican states. This project offers an outstanding example of what can be accomplished through international cooperation between Mexico, the U.S., and Canada. As the result of many years of hard work, financial support, and leadership by SEMARNAT, INE, U.S. EPA, WGA, the NACEC, the TAC, the SEAs, and many others, the Mexico NEI for the six northern states is complete.

In some ways, the development of the Mexico NEI has just begun. The Mexico NEI project has identified a process by which future inventories can be developed. Also, much has been learned about the types of data that the various Mexican governmental agencies collect and can provide to the inventory effort; and at the same time, the lack of data is apparent in the confidence ratings of some of the emissions categories.

As the Mexico NEI results are used for their intended purpose—to support air quality analyses in Mexico and throughout North America—there will be a need to refine the inventory for use in photochemical and dispersion models. Specifically, approaches and data needed to temporally and spatially allocate the emissions, chemically speciate the PM and VOC emissions, and project the base year inventory into the future, will be needed.

Based upon the analysis presented in the previous sections of this report, and the summary of results presented in section 8.1, several recommendations can be made regarding the inventory process, methodologies, data, and results as they pertain to the five source types: point, area, mobile, nonroad, and natural. Recommendations to improve the Mexico NEI generally fall into two broad categories: improving the quality, and increasing the quantity of data used to estimate emissions. Please note that these recommendations, which are discussed below, are the opinion of the Mexico NEI contractor team, and may not necessarily reflect the views of the project sponsors, SEMARNAT, or INE.

8.2.1 Point Source Recommendations

- The point source inventory relies upon existing emissions data from DATGEN, the COAs, the SEAs, SENER, and PEMEX. As the RETC program matures, and its laws and regulations are fully implemented and enforced with regard to point source emissions reporting, the COAs submitted under this program should become more complete and consistent. This should result in a more accurate point source inventory in the future. However, the number of facilities submitting COAs needs to be increased. Currently, SEMARNAT is making great progress in coordinating with the SEAs to yield better COA data from the state jurisdiction point sources. Providing SEAs with guidance on consistent reporting formats will also help to ensure data are consistent across all states, thus making the inventory process more efficient and results more accurate. Also, continued development and implementation of electronic submittal tools is recommended.

- Currently, NH_3 emissions are not recorded by facilities on their COAs. These should be included in the future to provide a comprehensive set of emissions data for air quality analyses.

- Estimates of VOC emissions from industrial facilities are not consistently estimated and reported. Developing industry-specific methods for testing and/or estimating these emissions (along with the other pollutants) would increase the quantity and quality of the emissions data.

- The majority of the point source emissions in the Mexico NEI for the six northern border states come from utilities, petroleum and coal product manufacturing, nonmetallic minerals manufacturing, primary metal manufacturing, and mining. These sectors could be used to set priorities for development of Mexico-specific emission factors.

8.2.2 Area Source Recommendations

- Many of the area source methodologies used national-level statistics for activity data (e.g., fuel use, surface coating quantities, dry cleaning solvents, etc.). However, higher resolution activity data, such as state- or municipality-level, was typically unavailable. As a result, various spatial allocation methods were used to disaggregate the national-level activity data down to the municipality-level. These methods often relied on population or employee counts. These methods are likely to be approximations of the action activity data distribution. Identifying and using higher resolution activity data will improve the overall quality of the area source inventory.

- Evaporative VOC sources include many different types of source categories. For some VOC categories, trade associations provided national-level activity data (i.e., paint and ink statistics from ANAFAPYT and dry cleaning solvent statistics from CANALAVA). Unfortunately, for other VOC categories (i.e., consumer solvents and degreasing), an appropriate trade association could not be identified. Consequently, U.S. default per capita or per employee emission factors were used to estimate emissions instead of Mexico-specific activity data which resulted in the VOC emissions from both consumer solvents and degreasing being relatively significant as compared to the emissions from other VOC sources. These emission estimates for degreasing and consumer solvents are highly uncertain because of the use of U.S. emission factors. Identifying and obtaining information from the appropriate trade associations will improve the accuracy of the emission estimates for these categories.

- Agricultural sources include a wide variety of fugitive dust sources (i.e., agricultural tillage and beef cattle feedlots), ammonia sources (i.e., livestock ammonia and fertilizer application), combustion sources (i.e., agricultural burning) and evaporative VOC sources (i.e., pesticide application). A key source of activity data for the agricultural sectors in general is SAGARPA, but the data that they were able to provide were limited to some estimates of crop acreage and livestock population. On-going and increased interaction with SAGARPA is needed to identify and/or develop other needed activity data for use in the Mexico NEI in the future. These activity data include region-specific agricultural practices (i.e., field and pruning burning, fertilizer application, and pesticide application), as well as crop calendars and other detailed activity data.

- The most significant sources of PM_{10} and $PM_{2.5}$ emissions are paved and unpaved road dust. Emissions were estimated using the most up-to-date emission methodologies from U.S. EPA. However, these methodologies incorporate emission factor equations that require a large number of location-specific input parameters (i.e., silt loading, silt content, average vehicle speed, average vehicle weight, average silt moisture content, and number of precipitation days). With the exception of the number of precipitation days, the other relevant input parameters were based upon two limited data sets from the cities of Ciudad Juárez and Chihuahua City. The input parameters from these two data sets are likely not representative of conditions throughout the country of Mexico. Future development of these location-specific input parameters will refine the accuracy of the paved and unpaved road dust emissions.

8.2.3 Motor Vehicle Recommendations

- A crucial type of on-road motor vehicle activity data is VKT. Because the Mexico NEI was developed at the state- and municipality-level, VKT estimates also were developed at the state- and municipality-level. Due to limitations in other traditional sources of VKT data, the Mexico NEI used municipality-level VKT estimates based upon per capita VKT rates developed from modeled traffic volumes and congestion levels for representative urban areas of different size. As part of the first-time development of the Mexico NEI (i.e., a national inventory with municipality-level detail), this methodology was appropriate. However, additional collection and development of travel demand models, motor vehicle fuel statistics, vehicle registration statistics, and other motor vehicle-related surveys can be used to improve the VKT estimates used in the Mexico NEI.

- On-road motor vehicle emissions were estimated using emission factors derived from the MOBILE6-Mexico emission factor model. MOBILE6-Mexico represents the most up-to-date and representative emission factor model for use in Mexico. However, there are some potential areas for improvement. The basic emission rates contained in the model are based upon fairly limited vehicle testing conducted in Mexico City, Ciudad Juárez, and Aguascalientes; additional vehicle testing would improve the quality of these basic emission rates

- Another important type of on-road motor vehicle activity data is fleet characteristics. This includes data such as registration data, fleet age distribution, VKT mixes, etc. Some limited studies have been conducted in Mexico with the results applied throughout the country; while in other cases, U.S. data were utilized. Further studies could be used to improve the fleet characteristic information that is used to estimate on-road motor vehicle emissions.

8.2.4 Nonroad Mobile Source Recommendations

- Nonroad mobile sources in previous Mexican emissions inventories have been limited to aircraft, locomotives, and commercial marine vessels (included as area sources in this report). The Mexico NEI includes two additional types of nonroad mobile sources that have not been previously included in Mexican emissions inventories (i.e., agricultural equipment and construction equipment). There are, however, a number of other nonroad equipment types that are not included in the Mexico NEI (i.e., industrial/commercial equipment, recreation vehicles and boats, lawn and garden equipment, oil field and airport service support equipment, and logging equipment). Although these have been identified as being less significant source categories in U.S. emissions inventories, it is currently unclear to what extent they are important in Mexico. Future work concerning nonroad mobile sources may focus on development of activity data for these categories which are currently excluded.

- The Mexico NEI nonroad mobile source estimates used equipment populations that were either old (i.e., for agricultural equipment) or extrapolated from the U.S. (i.e., for construction equipment). The nonroad mobile source emission estimates can be improved by obtaining up-to-date, Mexico-specific equipment population statistics. This will require coordination with various government agencies and/or industry associations.

- The Mexico NEI nonroad mobile source estimates also rely upon annual hours of operation that have been adjusted based upon agricultural diesel fuel use estimates from the national fuels balance. A survey of Mexico nonroad equipment operations would provide a more accurate estimate of annual hours of operation.

8.2.5 Natural Source Recommendations

- In the GloBEIS model, biogenic emissions are a function of meteorological data (i.e., temperature and cloud cover). To the greatest extent possible, Mexico-specific meteorological data were collected and used in the Mexico NEI. However, considerable data gaps were found in both the temperature and cloud cover data. In order to address these data gaps, temperature and cloud cover data profiles were developed. Assumptions used in the development of these profiles potentially resulted in an overestimate of VOC emissions (i.e., increased number of clear days and higher temperatures). Emissions uncertainty can be reduced in the future if the meteorological data gaps can also be reduced.

- In addition to meteorological data, biogenic emissions are also dependent upon the type of land use and land cover being considered. There are several areas of uncertainty associated with the Mexico land use and land cover data that were used in the Mexico NEI. First, actual urban areas are likely larger than what was reported in the land use data set. Also, in many cases, the data were vague and insufficiently specific with regards to detailed land use types or actual species present. This resulted in various assumptions that were made in order to run the GloBEIS model. In the future, efforts to improve the quality of land use and land cover will serve to reduce sources of uncertainty in the biogenic emission estimates.

- A final source of uncertainty in the biogenic emissions was the seasonality of crop data. GloBEIS allows the user to temporally define crop coverages to a high level of resolution (i.e., as fine as hourly). Unfortunately, detailed crop calendars could not be identified during the development of the Mexico NEI. This resulted in an assumption of year-round crop coverage. As a result, soil NO_x emissions likely have been overestimated in the Mexico NEI. As mentioned in Section 8.2.2, various types of agricultural activity data need to be obtained from SAGARPA in order to improve future inventories. Crop calendars are one of these types of data. If detailed crop calendars are obtained, then temporally variable crop coverages can be developed for Mexico which will result in emission estimates with reduced uncertainty.

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APPENDIX A

TECHNICAL MEMORANDA:

- **National Fuels Balance**
- **Development of Per Capita VKT Estimates**

Eastern Research Group, Inc.

Technical Memorandum

Subject: Mexico National Fuel Balance

Date: July 17, 2003

INTRODUCTION

Many of the area source categories contained within emissions inventories are fuel combustion sources or otherwise related to fuel usage. Therefore, it is important that fuel usage quantities are accurately estimated within an inventory domain. As part of the 1999 Mexico National Emissions Inventory (NEI), a national fuel balance was developed for the entire country of Mexico.

There were several data sources that were used in the development of the Mexico National Fuel Balance (NFB). Two key data sources were the Secretaría de Energía (SENER – Secretariat of Energy) and Petróleos Mexicanos (PEMEX – Mexico's nationalized petroleum company).

SCOPE

The Mexico NFB was developed for the year 1999 (i.e., the base year of the Mexico NEI). Although the Mexico NEI is being developed in phases (i.e., the first phase focused on the Mexico-U.S. border states and the second phase will cover the entire country), the Mexico NFB was developed for the entire country at once. The reason for this is that many of the references that were consulted included fuel information for all of Mexico.

It was intended that the Mexico NFB be developed at the state level (and if possible at the municipality level). At the current time, the Mexico NFB contains fuel data at various levels of disaggregation (i.e., regional, state, municipality, bulk terminal, and distribution plant). Additional research is being conducted to further disaggregate these fuel data.

The fuel use information contained in the Mexico NFB was used to calculate area source fuel combustion emissions. In addition, gasoline and LPG distribution emissions were estimated using information from the Mexico NFB.

METHODOLOGY

The first step of the fuel balance was to identify all relevant fuel types. These fuel types were identified in SENER's 1999 national energy balance (SENER, 2000a). A summary of this national energy balance is shown in Table 1 and Table 2. Table 1 shows primary energy consumption prior to transformation (i.e., fuel sent to refineries, coke plants, gas plants, or electricity generation facilities). Table 2 shows secondary energy consumption after transformation. All energy quantities are presented in units of petajoules (PJ or 10^{15} joules). In the supply and transformation sections of Table 1 and Table 2, positive values indicate energy inflows and negative values indicate energy outflows. Non-emitting energy flows (i.e., nuclear, hydroelectric, geothermal, and wind) are not included in Table 1 and Table 2.

Fuel usage was estimated by converting energy quantities to fuel quantities by using the equivalent energies identified by SENER. These equivalent energies are presented in Table 3. The converted fuel quantities for the 1999 national energy balance primary and secondary energy flows are presented in Table 4 and Table 5, respectively.

In addition to the fuel quantities estimated from SENER's national energy balance, further detailed information, such as distribution by sector or region, was obtained from several fuel-specific documents published by SENER ("Prospectivas"). These Prospectivas were published for natural gas, liquefied petroleum gas (LPG), and petrolíferos (petroleum liquids) (SENER, 2000b; SENER, 2000c; SENER, 2001a; SENER, 2001b; SENER, 2001c; SENER, 2002a; SENER, 2002b; and SENER, 2002c).

Detailed internal sales data from PEMEX were also obtained for petrolíferos, natural gas, and LPG (PEMEX, 2003b; PEMEX, 2003c). These internal sales data are currently at different levels of resolutions. The natural gas statistics were provided at the regional basis, while the LPG and petrolíferos statistics were supplied at the distribution plant and bulk terminal level of detail, respectively. A state-level listing of the bulk terminals and number of distribution plants is provided in Table 6.

For some fuels, fuel quantities were calculated from the national energy balance and were also available from PEMEX's internal sales data. In these situations, the internal sales data were used. Differences between the fuel quantities obtained from these two data sources were relatively small (i.e., within ±5 percent for any specific fuel).

PEMEX also provided fuel specifications for commercially available fuels which it produces and distributes (PEMEX, 2003d; PEMEX, 2003e). These specifications were used to determine fuel characteristics that were needed for estimating emissions in the Mexico NEI (i.e., fuel sulfur content).

RESULTS

A fuel-by-fuel description of the Mexico NFB is presented below. The numbers represent the distribution of the total internal gross supply quantities for a particular fuel. As shown in Table 4 and Table 5, total internal gross supply is the summation of production, imports, inventory variation, exports, accidental releases, and maquiladora exchange. The summary below also indicates how the estimated fuel quantities were used in the Mexico NEI.

Metallurgical Coal (Primary)

The total internal gross supply of metallurgical coal estimated from the national energy balance was 2.72×10^6 Mg/year. This entire quantity was transformed and utilized at coke plants.

Emissions from industrial coal combustion for the purpose of coke production were included in the Mexico NEI as an area source category. Metallurgical coal consumption and emissions were allocated based upon the number of state- and municipality-level employees within the coke industry (CMAP code 3540) (INEGI, 1999b).

Thermal Coal (Primary)

The total internal gross supply of thermal coal estimated from the national energy balance was 9.47×10^6 Mg/year. This matched the quantity of 9.47×10^6 Mg/year identified in the 1999 Power Plant Inventory for Mexico (SENER, 2003). The entire quantity of thermal coal was transformed and consumed for electricity generation at the two coal-fired power plants in Piedras Negras, Coahuila.

Emission estimates from the 1999 Power Plant Inventory were directly incorporated into the Mexico NEI as point sources (SENER, 2003). Therefore, the estimated quantity of thermal coal was not used to estimate area source fuel combustion emissions.

Crude Oil (Primary)

The total internal gross supply of crude oil estimated from the national energy balance was 1.30×10^6 bbl/day. Most of this quantity (1.28×10^6 bbl/day) was transformed at one of Mexico's six petroleum refineries (i.e., Cadereyta, Madero, Minatitlán, Salamanca, Salina Cruz, and Tula). The remaining crude oil (2×10^4 bbl/day) was identified as losses and statistical differences.

The estimated quantity of crude oil was not used to estimate emissions in the Mexico NEI because none of it was used for combustion purposes; however, emissions were estimated from refined petroleum products from this crude oil.

Condensate (Primary)

The total internal gross supply of condensate estimated from the national energy balance was 9.34×10^4 bbl/day. Most of this quantity (8.95×10^4 bbl/day) was transformed at gas plants with most of the remainder (4×10^3 bbl/day) being sent to petroleum refineries.

Area source emissions were not estimated for the combustion of condensate because virtually all condensate fuel was sent to either gas plants or refineries.

Unassociated Natural Gas (Primary)

The total internal gross supply of unassociated natural gas estimated from the national energy balance was 3.58×10^7 m^3/day. Of this quantity, 1.38×10^7 m^3/day was sent to gas plants. An additional 7.98×10^5 m^3/day of secondary natural gas were identified as self-consumption and statistical differences.

Of the remaining 2.12×10^7 m^3/day of unassociated natural gas, a majority of the fuel (1.91×10^7 m^3/day) was consumed by the industrial sector with the remainder being consumed by the residential sector.

Area source emissions were estimated for unassociated natural gas used by the industrial and residential sectors. Population- or employee-based allocation was not required for the different sectors of primary unassociated natural gas combustion because sector-specific sales information was already available (SENER, 2000a).

Associated Natural Gas (Primary)

The total internal gross supply of primary associated natural gas estimated from the national energy balance was 8.66×10^7 m^3/day. Of this quantity, most (8.62×10^7 m^3/day) was sent to gas plants. The remaining 3.96×10^5 m^3/day of associated natural gas were identified as self-consumption and statistical differences.

Area source emissions were not estimated for the combustion of associated natural gas because virtually all fuel was sent to gas plants.

Bagasse (Primary)

The total internal gross supply of bagasse estimated from the national energy balance was 1.29×10^7 Mg/year. Most of this bagasse was consumed by the industrial sector (1.23×10^7 Mg/year) with the remainder being used for non-energy uses. Because bagasse is a by-product of sugar cane residue, it was solely consumed by sugar processing facilities.

Emissions from bagasse combustion were included in the Mexico NEI as an area source category. Bagasse consumption and emissions were allocated based upon the number of state- and municipality-level employees within the sugar industry (CMAP code 3118) (INEGI, 1999b).

Wood (Primary)

The total internal gross supply of wood estimated from the national energy balance was 1.72×10^7 Mg/year. The entire quantity of wood was consumed by the residential sector. Recent estimates of municipality-level residential wood use were identified and were used to estimate residential wood combustion emissions (Masera et al., 2003).

Emissions from wood combustion were included in the Mexico NEI as an area source category.

Coke (Secondary)

The total internal gross supply of coke estimated from the national energy balance was 1.27×10^6 Mg/year. An additional 2.28×10^6 Mg/year of coke were produced in transformation processes at coke plants and refineries. A total of 3.82×10^4 Mg/year were identified as self-consumption.

Of the remaining coke (3.51×10^6 Mg/year), most was consumed by the industrial sector (3.50×10^6 Mg/year) with the remainder being used for non-energy uses.

Industrial coke use occurs primarily in the iron and steel manufacturing sector. It was assumed that these types of sources were included in the Mexico NEI point source inventory. Therefore, industrial coke combustion was not included in the Mexico NEI as an area source category.

LPG (Secondary)

The total internal gross supply of LPG estimated from the national energy balance was 9.23×10^4 bbl/day. An additional 2.32×10^5 bbl/day of LPG were produced in transformation processes at refineries and gas plants. A total of 1.27×10^4 bbl/day were identified as self-consumption.

Of the remaining 3.12×10^5 bbl/day of LPG, the largest quantity (2.17×10^5 bbl/day) was consumed by the residential sector. Lesser LPG quantities were consumed by the commercial, transportation (on-road motor vehicles), industrial, and agricultural sectors.

The total of 3.12×10^5 bbl/day of LPG combusted (as estimated from the national energy balance) is close to the reported PEMEX internal fuel sales for LPG of 3.19×10^5 bbl/day.

The estimated quantity of LPG was used to estimate area source fuel combustion emissions for the residential, commercial, industrial, agricultural, and transportation sectors. LPG quantities were also used to estimate LPG distribution emissions.

Population- or employee-based allocation was not required for the different sectors of LPG combustion because sector-specific sales information was already available (SENER, 2000a).

Gasoline (Secondary)

The total internal gross supply of gasoline estimated from the national energy balance was 7.58×10^4 bbl/day. An additional 4.90×10^5 bbl/day of gasoline were produced in transformation processes at refineries and gas plants. A total of 3.35×10^4 bbl/day was identified as self-consumption.

Of the remaining 5.32×10^5 bbl/day of gasoline, a majority of the fuel (5.11×10^5 bbl/day) was consumed by the transportation sector (including on-road motor vehicles and aircraft) with the remainder being used for non-energy uses. Further disaggregation of transportation sector gasoline use resulted in the following consumption quantities: 5.1×10^5 bbl/day for on-road motor vehicles and 5.04×10^2 bbl/day for aircraft.

The total of 5.12×10^5 bbl/day of gasoline combusted (as estimated from the national energy balance) is very close to the reported PEMEX internal fuel sales for gasoline (including Magna and Premium gasolines) of 5.11×10^5 bbl/day.

The quantities of gasoline were not used to estimate on-road motor vehicle or aircraft emissions; these emissions were estimated using different methodologies. However, the gasoline quantities were used to estimate gasoline distribution emissions.

Kerosene (Secondary)

The total internal gross supply of gasoline estimated from the national energy balance was 2.39×10^2 bbl/day. An additional 5.90×10^5 bbl/day of kerosene were produced in transformation processes at refineries and gas plants. A total of 2.32×10^3 bbl/day was identified as self-consumption.

Of the remaining 5.64×10^4 bbl/day of kerosene, a majority of the fuel (5.53×10^4 bbl/day) was consumed by the transportation sector (aircraft) with smaller quantities being consumed by the residential, industrial, and agricultural sectors.

The total of 5.64×10^4 bbl/day of kerosene combusted (as estimated from the national energy balance) is very close to the reported PEMEX internal fuel sales for kerosene (including turbosina and diafano fuels) of 5.61×10^4 bbl/day.

The quantity of kerosene used by aircraft was not used to calculate area source emissions; the small quantity of non-aircraft kerosene was included in the area source emissions.

Diesel (Secondary)

The total internal gross supply of diesel estimated from the national energy balance was 2.97×10^4 bbl/day. An additional 2.76×10^5 bbl/day of diesel were produced in transformation processes at refineries and gas plants.

A total of 8.39×10^3 bbl/day of diesel was consumed by electricity generation facilities as estimated from the national energy balance. An additional 2.69×10^4 bbl/day were identified as self-consumption.

Of the remaining 2.71×10^5 bbl/day of diesel, the largest quantity (2.05×10^5 bbl/day) was consumed by the transportation sector (including on-road motor vehicles, commercial marine vessels, and railroads). Lesser diesel quantities were consumed by the agricultural, industrial, and commercial sectors. Further disaggregation of transportation sector diesel use resulted in the following consumption quantities: 1.79×10^5 bbl/day for on-road motor vehicles, 1.55×10^4 bbl/day for commercial marine vessels, and 1.04×10^4 bbl/day for railroads.

The total of 2.79×10^5 bbl/day of diesel combusted (as estimated from the national energy balance) is close to the reported PEMEX internal fuel sales for diesel (including industrial diesel and marine diesel fuels) of 2.72×10^5 bbl/day.

Emission estimates from the 1999 Power Plant Inventory were directly incorporated into the Mexico NEI as point sources (SENER, 2003). Therefore, the estimated quantity of diesel used for electricity generation was not included in the estimate of area source fuel combustion emissions. Likewise, the quantity of on-road motor vehicle diesel fuel was not used to estimate emissions. However, area source emissions were estimated for diesel used by the transportation (commercial marine and railroads), agricultural, industrial, and commercial sectors.

Commercial marine vessel diesel was allocated based upon port-level cargo volumes (INEGI, 2002). Railroad diesel was allocated based upon state-level track length (ESRI, 2003). Agricultural diesel was allocated based upon the number of state- and municipality-level agricultural employees (CMAP subsectors 0 through 19). Industrial diesel was allocated based upon the number of state- and municipality-level industrial employees (CMAP subsectors 20 through 39). Commercial diesel was allocated based upon the number of state- and municipality-level commercial employees (CMAP subsectors 50 through 80) (INEGI, 1999b).

Combustoleo (Secondary)

The total internal gross supply of combustoleo estimated from the national energy balance was 9.46×10^4 bbl/day. An additional 4.26×10^5 bbl/day of combustoleo were produced in transformation processes at refineries and gas plants.

A total of 3.80×10^5 bbl/day of combustoleo was consumed by electricity generation facilities as estimated from the national energy balance. This compared favorably to the quantity of 2.13×10^7 m^3/year (3.67×10^5 bbl/day) identified in the 1999 Power Plant Inventory for Mexico (SENER, 2003). An additional 2.44×10^4 bbl/day were identified as self-consumption and statistical differences.

The remaining 1.16×10^5 bbl/day of combustoleo were consumed by the industrial, commercial, and transportation (commercial marine vessels) sectors.

The total of 4.96×10^5 bbl/day of combustoleo combusted (as estimated from the national energy balance) is close to the reported PEMEX internal fuel sales for combustoleo (including intermedio 15 and industrial combustible fuels) of 4.75×10^5 bbl/day.

Emission estimates from the 1999 Power Plant Inventory were directly incorporated into the Mexico NEI as point sources (SENER, 2003). Therefore, the estimated quantity of combustoleo used for electricity generation was not included in the estimate of area source fuel combustion emissions. However, area source emissions were estimated for combustoleo used by the industrial, commercial, and transportation sectors.

Industrial combustoleo was allocated based upon the number of state- and municipality-level industrial employees (CMAP subsectors 20 through 39); commercial combustoleo was allocated based upon the number of state- and municipality-level commercial employees (CMAP subsectors 50 through 80) (INEGI, 1999b). Transportation (commercial marine vessel) combustoleo was allocated based upon port-level cargo volumes (INEGI, 2002).

Non-Energy Products (Secondary)

The total internal gross supply of non-energy products estimated from the national energy balance was 9.81×10^3 bbl/day. An additional 9.13×10^4 bbl/day of non-energy products were produced in transformation processes at refineries and gas plants. A total of 1.79×10^3 bbl/day was identified as self-consumption.

A total of 7.98×10^4 bbl/day of non-energy products were identified in the national energy balance after transformation processes. The estimated quantity of non-energy products was not used to estimate emissions in the Mexico NEI because none of these were used for combustion purposes.

Natural Gas (Secondary)

The total internal gross supply of secondary natural gas estimated from the national energy balance was 3.11×10^5 m^3/day. An additional 8.25×10^7 m^3/day of secondary natural gas were produced in transformation processes at refineries and gas plants.

A total of 2.24×10^7 m^3/day of secondary natural gas was consumed by electricity generation facilities as estimated from the national energy balance. This compared favorably to the quantity of 7.76×10^9 m^3/year (2.13×10^7 m^3/day) identified in the 1999 Power Plant Inventory for Mexico (SENER, 2003). An additional 3.51×10^7 m^3/day were identified as self-consumption and statistical differences.

Of the remaining 2.53×10^7 m^3/day of secondary natural gas, a majority of the fuel (2.09×10^7 m^3/day) was consumed by the industrial sector with smaller quantities being consumed by the residential, commercial, and transportation sectors, as well as non-energy uses.

Emission estimates from the 1999 Power Plant Inventory were directly incorporated into the Mexico NEI as point sources (SENER, 2003). Therefore, the estimated quantity of secondary natural gas used for electricity generation was not included in the estimate of area source fuel combustion emissions. However, area source emissions were estimated for secondary natural gas used by the residential and commercial sectors.

Population- or employee-based allocation was not required for the different sectors of secondary natural gas combustion because sector-specific sales information was already available (SENER, 2000a).

SUMMARY

The Mexico NFB provides the foundation for many source categories within the Mexico NEI. Table 7 summarizes which categories were estimated using the results of the Mexico NFB.

Table 1. 1999 Mexico Energy Balance – Primary Energy

1999 Primary Energy (PJ)	Metallurg. Coal	Thermal Coal	Crude Oil	Condensate	Unassociated Gas	Associated Gas	Bagasse	Wood	Primary Total
Supply									
Production	55.567	144.898	6,266.618	124.917	422.171	1,456.595	91.979	249.517	9,258.941
Imports	39.804	21.437	0.000	0.000	0.000	0.000	0.000	0.000	21.437
Inventory Variation	-21.774	11.757	16.176	-0.047	0.000	-4.255	0.000	0.000	23.631
Exports	-1.629	0.000	-3,349.974	0.000	0.000	0.000	0.000	0.000	-3,351.603
Accidental Releases	0.000	0.000	-0.001	0.000	0.000	-189.340	-1.004	0.000	-190.345
Maquila Exchange	0.000	0.000	-122.183	0.000	0.000	0.000	0.000	0.000	-122.183
Total Internal Gross Supply	**71.968**	**178.092**	**2,810.636**	**124.870**	**422.171**	**1,263.000**	**90.975**	**249.517**	**5,641.507**
Transformation									
Coke Plant	-63.786	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-63.786
Refinery	0.000	0.000	-2,764.645	-5.291	0.000	0.000	0.000	0.000	-2,769.936
Gas Plant	0.000	0.000	0.000	-119.626	-162.440	-1,257.216	0.000	0.000	-1,539.282
Electricity Generation	0.000	-178.690	0.000	0.000	0.000	0.000	0.000	0.000	-680.936
Self-consumption	0.000	0.000	0.000	0.000	-10.213	-63.210	0.000	0.000	-73.423
Statistical Differences	-8.182	0.598	-13.317	0.047	0.801	57.426	0.000	0.000	45.555
Losses	0.000	0.000	-32.674	0.000	0.000	0.000	0.000	0.000	-32.674
Total After Transformation	**0.000**	**0.000**	**0.000**	**0.000**	**250.319**	**0.000**	**90.975**	**249.517**	**590.811**
Consumption									
Non-Energy	0.000	0.000	0.000	0.000	0.000	0.000	4.393	0.000	4.393
Industrial	0.000	0.000	0.000	0.000	225.287	0.000	86.582	0.000	311.869
Residential/ Commercial	0.000	0.000	0.000	0.000	25.032	0.000	0.000	249.517	274.549
Transportation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Agricultural	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Total Consumption	**0.000**	**0.000**	**0.000**	**0.000**	**250.319**	**0.000**	**90.975**	**249.517**	**590.811**

Table 2. 1999 Mexico Energy Balance – Secondary Energy

1999 Secondary Energy (PJ)	Coke	LPG	Gasoline/ Naphtha	Kerosene	Diesel	Combustoleo	Non-Energy Products	Natural Gas	Electricity	Secondary Total
Supply										
Production	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Imports	7.793	132.356	195.737	5.628	57.454	217.298	0.000	51.874	2.358	670.498
Inventory Variation	25.796	-0.458	11.631	-1.292	6.984	5.465	-0.254	0.345	0.000	48.217
Exports	-0.018	-6.097	-134.123	-4.830	-18.850	-2.075	-20.890	-49.518	-0.472	-236.873
Accidental Releases	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Maquila Exchange	0.000	0.000	68.561	0.000	16.609	0.000	0.000	0.000	0.000	85.170
Total Internal Gross Supply	**33.571**	**125.801**	**141.806**	**-0.494**	**62.197**	**220.688**	**-21.144**	**2.701**	**1.886**	**567.012**
Transformation										
Coke Plant	59.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	59.002
Refinery	1.703	42.263	759.326	121.054	576.430	993.501	104.901	65.263	0.000	2,664.441
Gas Plant	0.000	274.232	157.095	0.854	0.935	0.447	92.077	940.768	0.000	1,466.408
Electricity Generation	0.000	0.000	0.000	0.000	-17.540	-887.531	0.000	-272.971	651.301	-526.741
Self-consumption	-1.014	-17.359	-62.714	-4.803	-56.299	-89.662	-3.859	-469.140	-32.904	-737.754
Statistical Differences	0.000	0.000	0.000	0.000	0.000	32.743	0.000	41.901	0.216	74.860
Transformation Losses	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-98.510	-98.510
Total After Transformation	**93.262**	**424.937**	**995.513**	**116.611**	**565.723**	**270.186**	**171.975**	**308.522**	**521.989**	**3,468.718**
Consumption										
Non-Energy	0.138	0.038	38.417	0.080	0.000	0.000	171.975	44.568	0.000	255.216
Industrial	93.124	18.696	0.000	0.519	54.336	235.248	0.000	255.317	310.402	967.642
Residential/ Commercial	0.000	354.365	0.000	1.565	3.532	31.879	0.000	8.292	179.161	578.794
Transportation	0.000	50.563	957.096	114.394	428.366	3.059	0.000	0.345	3.640	1,557.463
Agricultural	0.000	1.275	0.000	0.053	79.489	0.000	0.000	0.000	28.786	109.603
Total Consumption	**93.262**	**424.937**	**995.513**	**116.611**	**565.723**	**270.186**	**171.975**	**308.522**	**521.989**	**3,468.718**

Table 3. 1999 Mexico Energy Balance – Equivalent Energies

Fuel	Equivalent Energy
Metallurgical coal – national	23,483 MJ/Mg
Metallurgical coal – international	29,559 MJ/Mg
Thermal coal – national	18,872 MJ/Mg
Thermal coal – international	18,360 MJ/Mg
Crude oil/petroleum equivalents	5,908 MJ/bbl
Condensate	3,661 MJ/bbl
Unassociated gas	32,292 kJ/m^3
Associated gas	39,972 kJ/m^3
Bagasse	7,055 MJ/Mg
Wood	14,486 MJ/Mg
Coke – coal	26,521 MJ/Mg
Coke – petroleum	31,672 MJ/Mg
Liquefied petroleum gas (LPG)	3,734 MJ/bbl
Gasoline/naphtha	5,126 MJ/bbl
Kerosene	5,665 MJ/bbl
Diesel	5,729 MJ/bbl
Combustoleo	6,392 MJ/bbl
Natural gas	33,427 kJ/m^3
Natural gas – export	35,228 kJ/m^3
Natural gas – import	34,376 kJ/m^3

Source: SENER, 2000a

MJ = megajoule (10^6 joules)
kJ = kilojoule (10^3 joules)
Mg = megagram (10^6 grams)
bbl = barrel
m^3 = cubic meter

Table 4. 1999 Mexico Energy Balance – Primary Energy Converted Fuel Quantities

1999 Primary Fuels	Metallurgical Coal	Thermal Coal	Crude Oil	Condensate	Unassociated Gas	Associated Gas	Bagasse	Wood
Units	Mg/yr	Mg/yr	bbl/day	bbl/day	10^6 m^3/day	10^6 m^3/day	Mg/yr	Mg/yr
Supply								
Production	2,366,265.0	7,677,935.6	2,906,028.5	93,482.2	35.818	99.837	13,037,420.3	17,224,699.7
Imports	1,346,594.9	1,167,592.6	0.0	0.0	0.000	0.000	0.0	0.0
Inventory Variation	-927,223.9	622,986.4	7,501.3	-35.2	0.000	-0.292	0.0	0.0
Exports	-69,369.3	0.0	-1,553,488.7	0.0	0.000	0.000	0.0	0.0
Accidental Releases	0.0	0.0	-0.5	0.0	0.000	-12.978	-142,310.4	0.0
Maquila Exchange	0.0	0.0	-56,660.1	0.0	0.000	0.000	0.0	0.0
Total Internal Gross Supply	**2,716,266.6**	**9,468,514.6**	**1,303,380.6**	**93,447.0**	**35.818**	**86.567**	**12,895,109.9**	**17,224,699.7**
Transformation								
Coke Plant	-2,716,262.8	0.0	0.0	0.0	0.000	0.000	0.0	0.0
Refinery	0.0	0.0	-1,282,053.1	-3,959.5	0.000	0.000	0.0	0.0
Gas Plant	0.0	0.0	0.0	-89,522.7	-13.782	-86.171	0.0	0.0
Electricity Generation	0.0	-9,468,524.8	0.0	0.0	0.000	0.000	0.0	0.0
Self-consumption	0.0	0.0	0.0	0.0	-0.866	-4.332	0.0	0.0
Statistical Differences	0.0	0.0	-6,175.5	35.2	0.068	3.936	0.0	0.0
Losses	0.0	0.0	-15,152.0	0.0	0.000	0.000	0.0	0.0
Total After Transformation	**0.0**	**0.0**	**0.0**	**0.0**	**21.238**	**0.000**	**12,895,109.9**	**17,224,699.7**
Consumption								
Non-Energy	0.0	0.0	0.0	0.0	0.000	0.000	622,679.0	0.0
Industrial	0.0	0.0	0.0	0.0	19.114	0.000	12,272,430.9	0.0
Residential/ Commercial	0.0	0.0	0.0	0.0	2.124	0.000	0.0	17,224,699.7
Transportation	0.0	0.0	0.0	0.0	0.000	0.000	0.0	0.0
Agricultural	0.0	0.0	0.0	0.0	0.000	0.000	0.0	0.0
Total Consumption	**0.0**	**0.0**	**0.0**	**0.0**	**21.238**	**0.000**	**12,895,109.9**	**17,224,699.7**

Table 5. 1999 Mexico Energy Balance – Secondary Energy Converted Fuel Quantities

1999 Secondary Fuels	Coke	LPG	Gasoline/ Naphtha	Kerosene	Diesel	Combustoleo	Non-Energy Products	Natural Gas
Units	Mg/yr	bbl/day	bbl/day	bbl/day	bbl/day	bbl/day	bbl/day	10^6 m^3/day
Supply								
Production	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000
Imports	293,842.6	97,112.8	104,616.8	2,721.8	27,475.7	93,137.8	0.0	4.134
Inventory Variation	972,663.2	-336.0	6,216.5	-624.8	3,339.9	2,342.4	-117.8	0.028
Exports	-678.7	-4,473.5	-71,685.6	-2,335.9	-9,014.5	-889.4	-9,687.4	-3.851
Accidental Releases	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000
Maquila Exchange	0.0	0.0	36,644.2	0.0	7,942.8	0.0	0.0	0.000
Total Internal Gross Supply	**1,265,827.1**	**92,303.2**	**75,792.0**	**-238.9**	**29,743.9**	**94,590.8**	**-9,805.1**	**0.311**
Transformation								
Coke Plant	2,224,747.8	0.0	0.0	0.0	0.0	0.0	0.0	0.000
Refinery	53,769.9	31,009.4	405,841.8	58,544.5	275,660.7	425,832.4	48,645.9	5.349
Gas Plant	0.0	201,210.6	83,963.6	413.0	447.1	191.6	42,699.0	77.107
Electricity Generation	0.0	0.0	0.0	0.0	-8,388.0	-380,411.7	0.0	-22.373
Self-consumption	-38,233.9	-12,736.7	-33,519.2	-2,322.8	-26,923.3	-38,430.7	-1,789.5	-38.451
Statistical Differences	0.0	0.0	0.0	0.0	0.0	14,034.2	0.0	3.368
Transformation Losses	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.000
Total After Transformation	**3,506,110.9**	**311,786.5**	**532,078.2**	**56,395.8**	**270,540.4**	**115,806.6**	**79,750.2**	**25.311**
Consumption								
Non-Energy	**5,188.0**	**27.9**	**20,533.0**	**38.7**	**0.0**	**0.0**	**79,750.2**	**3.653**
Industrial	3,500,922.9	13,717.7	0.0	251.0	25,984.6	100,831.5	0.0	20.926
Residential/ Commercial	0.0	260,006.2	0.0	756.9	1,689.1	13,663.9	0.0	0.680
Transportation	0.0	37,099.3	511,545.2	55,323.6	204,853.5	1,311.1	0.0	0.028
Agricultural	0.0	935.5	0.0	25.6	38,013.3	0.0	0.0	0.000
Total Consumption	**3,506,110.9**	**311,786.5**	**532,078.2**	**56,395.8**	**270,540.4**	**115,806.6**	**79,750.2**	**25.287**

Table 6. Mexico Bulk Terminals and LPG Distribution Plants

State Code	State Name	Bulk Terminals	Number of LPG Distribution Plants
01	Aguascalientes	Aguascalientes	2
02	Baja California	Ensenada, Mexicali, Rosarito	4
03	Baja California Sur	La Paz	6
04	Campeche	Campeche	3
05	Coahuila	Monclova, Sabinas, Saltillo	22
06	Colima	Colima, Manzanillo	5
07	Chiapas	Tapachula, Tuxtla Gutiérrez	13
08	Chihuahua	Chihuahua, Ciudad Juárez, Parral	25
09	Distrito Federal	Añil, Azcapotzalco, Barranca del muerto	3
10	Durango	Durango, Gómez Palacio	15
11	Guanajuato	Celaya, Irapuato, León, Salamanca	24
12	Guerrero	Acapulco, Iguala	13
13	Hidalgo	Pachuca, Tula	16
14	Jalísco	Castillo, Guadalajara	37
15	México	San Juan Ixhuatepec, Toluca	35
16	Michoacán	Lázaro Cárdenas, Morelia, Uruapan, Zamora	22
17	Morelos	Cuautla, Cuernavaca	7
18	Nayarit	Tepic	6
19	Nuevo León	Cadereyta, San Rafael, Santa Catarina	36
20	Oaxaca	Oaxaca, Salina Cruz	14
21	Puebla	Puebla, Tehuacán	22
22	Querétaro	Querétaro	6
23	Quintana Roo	None	3
24	San Luis Potosí	Ciudad Valles, Matehuala, San Luis Potosí	12
25	Sinaloa	Culiacán, Guamuchil, Mazatlán, Topolobampo	7
26	Sonora	Cananea, Ciudad Obregón, Guaymas, Hermosillo, Magdalena, Navojoa, Nogales	15

Table 6. (Continued)

State Code	State Name		
27	Tabasco	Frontera, Villahermosa	8
28	Tamaulipas	Ciudad Mante, Ciudad Victoria, Madero, Nuevo Laredo, Reynosa	29
29	Tlaxcala	None	5
30	Veracruz	Bajos de la Gallega, Escamela, Jalapa, Minatitlán, Pajaritos, Perote, Poza Rica, Tierra Blanca, Veracruz	48
31	Yucatán	Mérida, Progreso	5
32	Zacatecas	Zacatecas	20
	Total	**81**	**488**

Table 7. Source Categories Estimated Using Results of 1999 Mexico Fuel Balance

Fuels	Area – Industrial Fuel Combustion	Area – Commercial Fuel Combustion	Area – Residential Fuel Combustion	Area – Transportation Fuel Combustion	Area – Agricultural Fuel Combustion	Other Source Categories	NOTES
Primary							
Metallurgical Coal	X						
Thermal Coal							Power plant emissions obtained from SENER.
Crude Oil							No combustion emissions.
Condensate							No combustion emissions.
Unassociated Natural Gas	X		X				
Associated Natural Gas							No combustion emissions.
Bagasse	X						
Wood			X				
Secondary							
Coke							Emissions assumed to be estimated in point source inventory.
LPG	X	X	X	X	X	LPG distribution	
Gasoline/ Naphtha						Gasoline distribution	Motor vehicle and aircraft emissions estimated using different methodology.
Kerosene	X		X		X		Aircraft emissions estimated using different methodology.
Diesel	X	X		X	X		Power plant emissions obtained from SENER. Motor vehicle emissions estimated using different methodology.
Combustoleo	X	X		X			Power plant emissions obtained from SENER.
Non-Energy Products							No combustion emissions
Natural Gas	X	X	X	X			Power plant emissions obtained from SENER.

MEXICO's NATIONAL EMISSION INVENTORY PROJECT

Estimation of Travel Demand and Vehicular Traffic Congestion of Mexican Urban Areas

I. Introduction

The Mexico's National Emissions Inventory (NEI) project is an initial attempt to establish the order of magnitude of emissions that result from human activity throughout the country, including those resulting from the use of motorized vehicles, and more specifically from the different levels of traffic congestions taking place at urban areas. Travel demand and patterns vary across cities and towns in Mexico, and their estimation aimed at planning future transportation infrastructure and making decisions over specific projects require considerable effort and individual attention to each urban area case. Yet covering such an extensive area and diversity in urban conditions within the Mexican territory for the broader scope of emissions estimation per se, together with the preliminary nature of the Mexico NEI project, suggest the use of a simplified approach when estimating travel demand and congestion. The present report describes such approach and its preliminary results.

Segmentation by urban area size

The complexities involved in evaluating traffic and emissions for each and every urban area in the country, provide an appealing argument in favor of developing a single average of the daily emission mass per capita, that could be used anywhere in Mexico. This simplistic approach though assumes that all urban areas have similar unit congestion levels, or that the variance can be disregarded.

It is quite evident that as cities grow, the ability to keep up with the demand for transportation infrastructure diminishes, and thus the phenomenon of traffic congestion starts taking place more often and with more intensity; thus an initial recommendation for a more accurate estimation has been to differentiate between traffic congestion and emissions per capita from urban areas of different sizes. Average emissions per capita can then be applied to urban areas under the same size category.

The following seven categories of urban area sizes have been suggested:

- a) small towns (less than 25,000 pop)
- b) medium towns (25,000 to 100,000 pop)
- c) large towns (100,000 to 250,000 pop)
- d) small cities (250,000 to 1,000,000 pop)
- e) medium cities (1,000,000 to 2,000,000 pop)
- f) large cities (over 2,000,000 pop)
- g) Mexico City

Under the current phase of the project, traffic volumes and congestion were modeled for a selected urban area in each of the first six size categories, in addition to the Mexico City metropolitan area. Table 1 shows the urban areas selected and corresponding population.

Table 1. Urban areas selected for travel demand and vehicle traffic congestion estimation.

Category	Name	Population 90	Population 95	Annual growth rate	Estimated Population 99
a	Castaños (Coahuila)	18,368	19,035	0.7%	19,586
b	Río Bravo (Tamaulipas)	67,092	74,913	2.2%	81,821
c	Ensenada (Baja California)	169,424	192,550	2.6%	213,304
d	Hermosillo (Sonora)	406,415	504,008	4.4%	598,703
e	Ciudad Juárez (Chihuahua)	798,499	1,010,533	4.8%	1,220,032
f	Monterrey metro area (Nuevo León)	2,523,626	2,907,255	2.9%	3,255,739
g	México City metro area	14,164,374	15,500,800	1.8%	16,660,173

Source: INEGI, 1990b; INEGI, 1995

The base year for the Mexico's NEI project has been set to 1999, thus the need to estimate population for such year. Figure 1 presents the reference street maps of the selected urban areas.

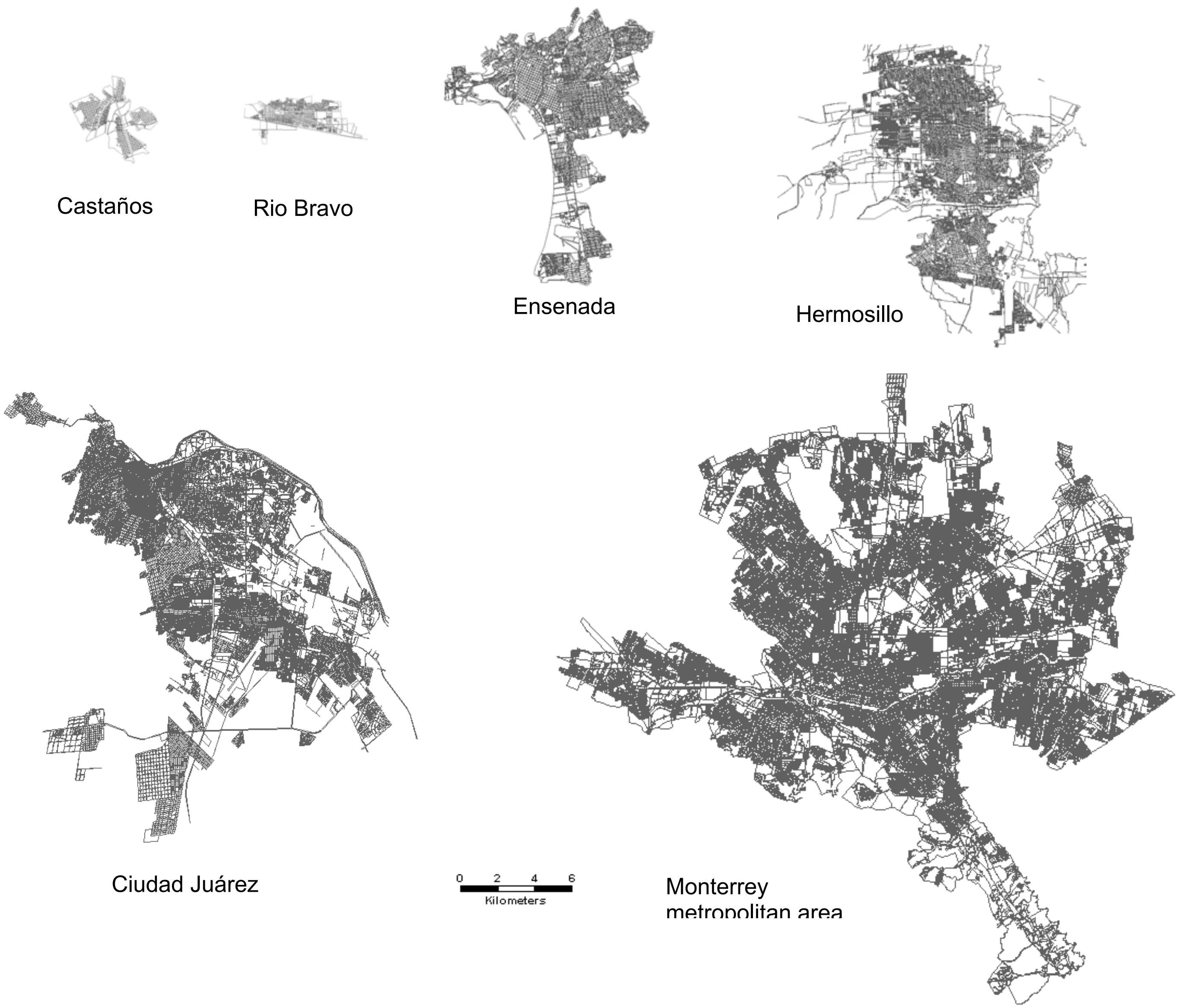


Figure 1. Scale street maps of selected urban areas (continues on next page).

Figure 1. Scale street maps of selected urban areas (continued from previous page).

II. Trip Generation

As a first step to establish traffic volumes, it has been recommended taking advantage of the known fact from research in the U.S., that the values of trip generation rates across urban area locations and sizes are fairly stable when disaggregated by socioeconomic conditions of the population such as household size, income, and employment. This stability intuitively suggests the transferability of known rates from the limited case studies in Mexico to other urban areas in the country. One known and documented case study is Ciudad Juárez, and thus its disaggregate trip rates as well as other traffic patterns can be borrowed and used as a basis for estimating traffic volumes in other urban areas.

Trip generation rates

The trip generation rates developed from the Juárez' transportation research program are shown in Tables 2 and 3 (IMIP, 1998). Table 2 presents production rates based on household size and household income. Table 3 presents attraction rates based on area type and employment by economic activity. These rates are expressed as person-trips per day.

Table 2. Juárez' disaggregate trip production rates (daily person-trips per household).

Trip purpose	HH income	HH size					
		1	2	3	4	5	6+
HBW	(1)	0.508	1.156	1.268	1.417	1.474	2.067
	(2)	0.902	1.479	1.705	1.726	2.096	2.400
	(3)	0.875	1.522	1.581	1.698	2.247	2.987
	(4)	1.000	1.708	1.847	1.800	2.438	2.762
	(5)	0.598	1.541	1.559	2.169	2.494	3.259
	(6)	0.801	2.307	2.180	2.119	2.622	3.196
HBO	(1)	2.609	3.761	6.142	9.435	13.264	13.111
	(2)	1.647	3.792	6.005	9.294	12.064	13.730
	(3)	1.933	3.921	5.767	9.221	12.955	13.430
	(4)	2.580	3.143	4.536	11.005	12.653	17.027
	(5)	1.933	4.349	7.240	10.707	10.839	12.742
	(6)	0.769	2.675	4.957	10.475	13.960	11.975
NHB	(1)	0.435	0.560	1.484	1.252	2.604	2.396
	(2)	0.352	0.820	1.515	1.891	2.479	2.335
	(3)	1.019	0.976	2.301	2.583	2.577	2.314
	(4)	1.230	1.659	1.766	3.550	3.299	3.060
	(5)	1.230	2.167	3.890	3.198	3.587	3.060
	(6)	0.609	1.882	1.726	2.929	5.643	1.995

The income ranges are as follows:

Range Code	Household income range (1996 daily min wages)	Household income range (1996 dollars)
1	0 to 2	$ 0.00 to $ 1,374 /year
2	2 to 6	$ 1,375 to $ 4,122 /year
3	6 to 10	$ 4,123 to $ 6,870 /year
4	10 to 12	$ 6,871 to $ 8,244 /year
5	12 to 18	$ 8,244 to $12,367 /year
6	over 18	$12,368 plus

Table 3. Juárez disaggregate trip attraction rates (daily person-trips per employee).

Trip purpose	Area Type	Household	Employment type		
			Basic	Retail	Service
HBW	CBD	0.125	2.000	1.557	1.899
	Urban	0.125	1.859	3.351	2.953
	Suburban	0.125	1.932	1.777	2.027
	Rural	0.125	1.497	1.615	2.099
HBO	CBD	0.569	0.031	22.417	36.758
	Urban	0.569	0.084	16.275	28.701
	Suburban	0.569	0.036	20.086	29.457
	Rural	0.569	0.195	3.423	2.881
NHB	CBD	0.127	0.062	14.438	0.409
	Urban	0.127	0.505	7.179	3.568
	Suburban	0.127	0.109	2.681	4.875
	Rural	0.127	0.627	10.485	2.694
TT	CBD	0.160	0.002	0.000	0.000
	Urban	0.170	0.000	0.129	0.000
	Suburban	0.180	0.012	0.549	0.102
	Rural	0.180	0.087	0.477	0.028

As depicted in these tables, the trip rates have been disaggregated into four different trip purposes:

1) Home-based-work (HBW) trips, which have the home as one of the trip ends, and work on the other, regardless of which is the origin or destination.
2) Home-based-other (HBO) trips, which have the home as one of the trip ends, and a non-work activity on the other, regardless of which is the origin or destination.
3) Non-home-based (NHB) trips, which have non-home trip ends.
4) Truck-taxi (TT) trips, which are delivery type NHB trips.

Table 3 shows in addition four different categories of Area Type. This is a measure of urban activity concentration also known as activity density. Such attribute needs to be computed for the different component zones of each urban area. Activity density is a function of the population and employment per unit area, as follows:

Activity Density = [Zone Population + (Zone Employment * F)] / Zone Acres (**Eq. 1**)

…where the normalization factor

F = Total study area Population / Total study area Employment (**Eq. 2**)

Area Type thus is categorized as follows:

Code	Area Type	Activity density
4	Rural	up to 26
3	Suburban	27 to 62
2	Urban	63 to 135
1	CBD	over 136

Zone structure

In order to develop trip generation patterns from expansion of the disaggregate trip rates, a zone structure with the required demographic variables like population, household size, income, and employment was established for each selected urban area. In this regard the Instituto Nacional de Estadística Geografía e Informática (INEGI) has demographic and socio-economic information for every urban area in Mexico, organized in zones or census tracts called Areas Geoestadísticas Básicas (AGEBs). These AGEB arrangements were used as the zone structures for each of the selected urban areas. Figure 2 shows such zone structure for Hermosillo. Appendix 1 shows the zone structure for the rest of the urban areas selected. These zone structures were developed into geographic information system (GIS) coverages, to store zonal attributes of the selected urban areas.

Figure 2. Example of zone structure (AGEBs) for Hermosillo.

Disaggregate household information

To develop total productions by zone, the trip generation model requires as input the total number of households under each category of size and income for each AGEB.

Regarding income, INEGI reports such variable on a per capita basis, so under the Juárez case study a linear regression was developed to correlate per capita income to a zonal household average income value, specially requested to INEGI from the 1990 census. The regression has the following form:

$$RelHHinc = 3.230 - 0.125*W_a - 0.078*W_b - 0.059*W_c \qquad \textbf{(Eq. 3)}$$

where:
RelHHinc: Zonal average household income/Regional average household income
W_a: Zonal Pop earning less than 1 minimum wage x100/Total zone pop
W_b: Zonal Pop earning between 1 and 2 minimum wages x100 /Total zone pop
W_c: Zonal Pop earning between 2 and 5 minimum wages x100/Total zonal pop

Household size is reported by INEGI as a zonal average at the AGEB level; this number was converted to a relative household size (RelHHsiz), dividing the zonal average household size value by the regional average household size value.

In order to convert the previously described zonal averages to actual number of households on each income and size category, the marginal curves in Figures 3 and 4 were developed. These are used by entering the relative zonal average (zonal average/regional average) on the X axis, and obtaining the percentage of households under each category, depicted by the corresponding marginal curves. The percentages are then applied to the total number of households in the AGEB.

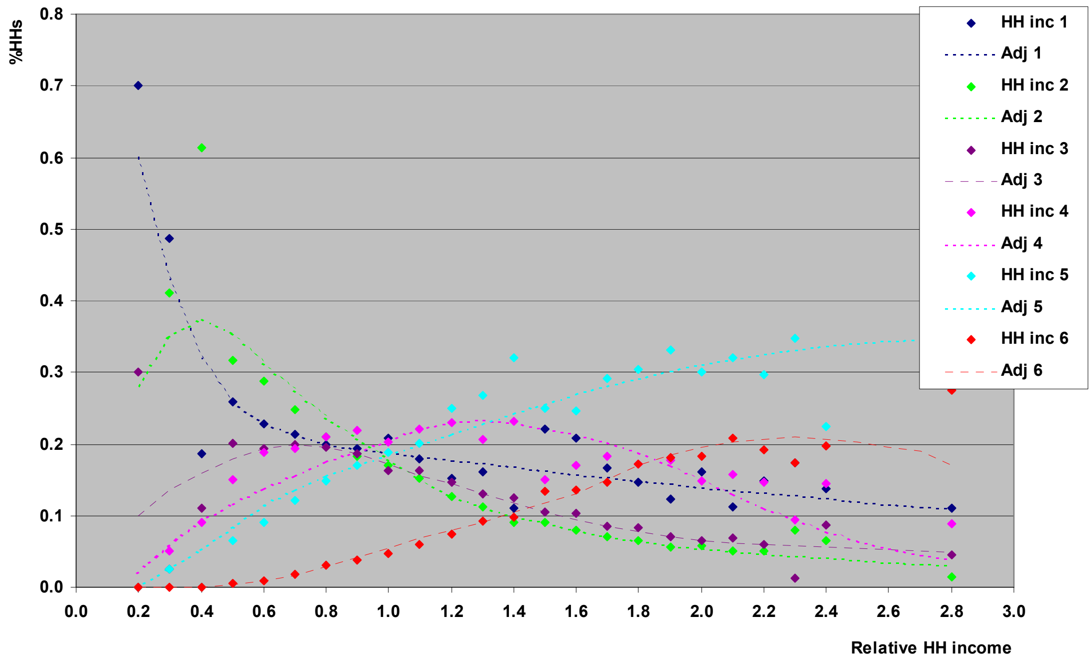


Figure 3. Distribution of households by relative household income (RelHHinc).

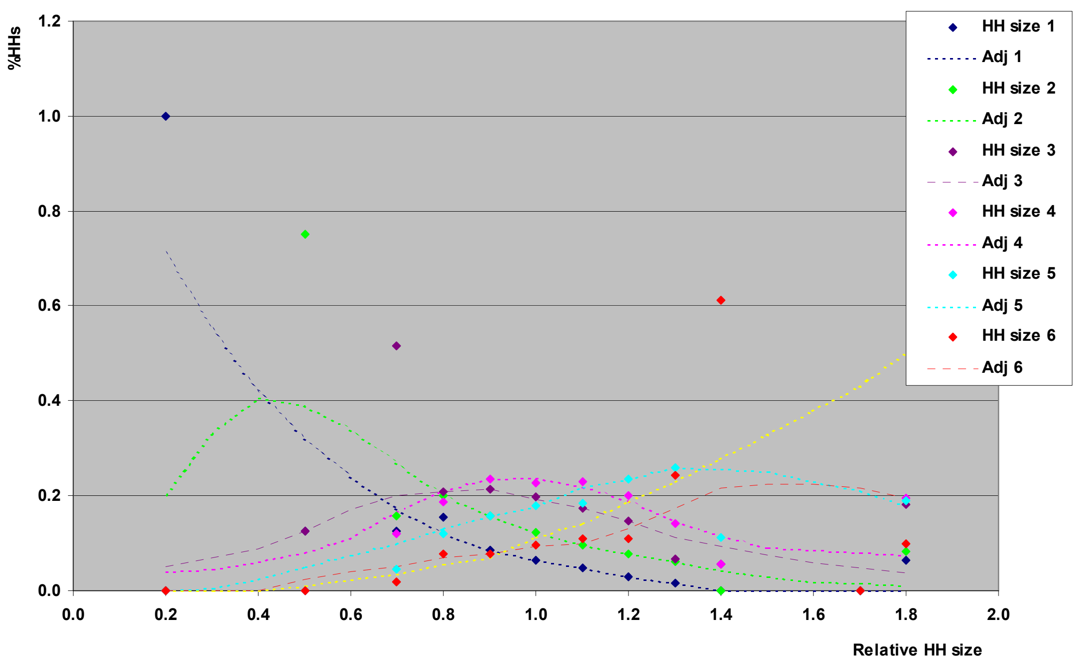


Figure 4. Distribution of households by relative household size (RelHHsiz).

The marginal curves were also developed under the Juárez' transportation research program, using extensively detailed databases specially requested to INEGI from the 1990 census.

Disaggregate employment information

Employment by economic activity for each AGEB is required by the trip generation model to establish trip attraction patterns. This information was obtained directly from the ROE or "Resultados Oportunos Económicos" for all the urban areas selected, but Castaños, since this information is available only for urban areas of 50,000+ population (INEGI, 1999c). Thus for this small town, a synthetic employment distribution was provided assuming that 50% of its employment would be located on its central area, covering about 25% of total urban surface. The other 50% was uniformly distributed in the rest of the urban area.

Balanced trip generation totals by AGEB

As previously indicated, the production trip rates are disaggregated by household size and income, therefore the total productions for a zone were obtained simply by multiplying the production trip rates (Table 2) times the number of households under each category of household size and income.

Similarly, total attractions for each zone were obtained by multiplying the attraction trip rates (Table 3) times the number of employees under the corresponding category of area type and economic activity.

The end result of this process is a production-attraction table by zone, for each trip purpose. In theory these productions and attractions under the same trip purpose need to add up to the same number, but since their development are based on different sources (household survey for productions, and workplace survey for attractions), it is common practice to "balance" or factor one to the other, usually to the more reliable one. For the Juárez' case, and thus for all of the selected urban areas, attractions were balanced to productions.

In the case of the TT trip purpose, the attractions were balanced to a control total equal of POP/20.9, which was the validated relationship in Juárez.

Table 4 shows a summary of raw production and attraction totals by trip purpose as well as the resulting balance factor, for all the selected urban areas.

Table 4. Resulting P-A (person-trips/day) totals for the selected urban areas.

		Castaños	Río Bravo	Ensenada	Hermosillo	Juárez (base 96)	Monterrey	México City
HBW	P	8,087	35,376	97,799	262,182	463,748	1,335,032	7,480,824
	A	6,501	31,673	128,852	311,294	530,313	1,855,649	1,835,297
	F_A	1.244	1.117	0.759	0.842	0.874	0.719	4.076
HBO	P	41,010	181,191	501,099	1,343,821	2,314,037	6,844,204	38,164,009
	A	44,532	236,452	879,372	2,232,804	2,722,470	13,412,955	16,449,908
	F_A	0.921	0.766	0.570	0.602	0.850	0.510	2.320
NHB	P	8,484	36,697	101,511	271,853	494,019	1,385,524	7,800,817
	A	12,205	54,082	192,786	473,823	581,214	2,554,513	4,641,036
	F_A	0.695	0.679	0.527	0.574	0.850	0.542	1.681
TT	P	937	3,915	10,206	28,646	50,964	155,777	807,778
	A	1,174	4,290	17,045	39,287	60,535	184,531	741,081
	F_A	0.798	0.913	0.599	0.729	0.842	0.844	1.090
Total Ps		58,518	257,179	710,615	1,906,502	3,322,768	9,720,537	54,253,428
Total balanced As		58,518	257,179	710,615	1,906,502	3,322,768	9,720,537	54,253,428

The balanced P-A by AGEB for each of the selected urban areas, were stored in the corresponding zonal GIS.

III. Vehicle-Trip Distribution

At the trip generation step, the total number of trips produced from, and attracted to each zone were estimated and presented in tabular format as depicted in Figure 5(a). This step provides a rough estimate of the trip-making potential for each zone, but does not determine the actual trip exchange with other zones.

The trip distribution step focuses on this trip exchange between zones, identifying from where and to where trips take place. Figure 5(b) exemplifies this step by showing schematically how the productions and attractions for zone 93 (totals of row ***i***=93 and column ***j***=93 respectively) end up "distributed" to the other zones in the study area. As seen in this example, trip exchange between zones is conventionally presented as a two-dimensional matrix array, where each cell represents the number of trips produced at zone ***i*** (row ***i***) and attracted to zone ***j*** (column ***j***). Next, this Production-Attraction matrix (also referred to as the "P-A matrix") is transformed to Origin-Destination (O-D), simply by reconfiguring the cell values to produce a matrix symmetric around the main diagonal. In this regard it is important to remember that only in the case of NHB trips, Production is considered synonymous to Origin and Attraction to Destination.

(a) Trip generation table

ZONE	Productions	Attractions
1	3,643	4,670
2	1,237	1,854
3	5,049	2,983
:	:	:
93	**9,351**	**5,360**
:	:	:
425	942	661

(b) Trip distribution matrix

j=93

P \ A	1	2	3	.	.	.	93	.	.	.	425	
1	215	306	421	.	.	.	128	.	.	.	13	
2	259	198	235	.	.	.	560	.	.	.	22	
3	362	268	210	.	.	.	376	.	.	.	69	
:	:	:	:	:	:	:	:	:	:	:	:	
i=93 93	163	754	196	.	.	.	412	.	.	.	63	Σ T93j= **9,351**
:	:	:	:	:	:	:	:	:	:	:	:	
425	16	39	53	.	.	.	12	.	.	.	321	
							Σ Ti93= **5,360**					

Figure 5. Schematic relationship between trip generation and trip distribution results.

<u>The traditional gravity model</u>

The traditional gravity model was originally developed from analogies with the physical world (Newton's gravity formulations), but its real strength comes from later improvements and derivation through entropy-maximizing considerations, which makes the model closely related to information theory, to error measures, and to maximum likelihood in statistics.

The doubly constrained version of the traditional gravity model has the following form:

$$T_{ij} = \beta_i * P_i * \alpha_j * A_j * f(t_{ij}) \quad \textbf{(Eq. 4)}$$

Where:

- T_{ij}: Trips produced in zone i and attracted to zone j.
- P_i: Total trips produced in zone i.
- β_i: Balancing factor for row i (production constraint).
- A_j: Total trips attracted to zone j.
- α_j: Balancing factor for column j (attraction constraint)
- $f(t_{ij})$: Impedance (decreasing) function, based on the travel time between zone i and zone j.

The two constraints that the model is required to meet are 1) that the sum of trips in any specific row of the matrix should equal the total number of trips produced in that zone, and 2) that the sum of trips in any specific column should correspond to the number of trips attracted to that zone (refer back to Figure 5). The two conditions can be written as:

$$\sum_{j} T_{ij} = P_i \qquad \textbf{(Eq. 5)}$$

$$\sum_{i} T_{ij} = A_j \qquad \textbf{(Eq. 6)}$$

The expression of both balancing factors β_i and α_j can thus be derived through simple algebraic manipulations of Equations 4 to 6. These have the following forms:

$$\beta_i = \frac{1}{\sum_{j} \alpha_j * A_j * f(t_{ij})} \qquad \textbf{(Eq. 7)}$$

$$\alpha_j = \frac{1}{\sum_{i} \beta_i * P_i * f(t_{ij})} \qquad \textbf{(Eq. 8)}$$

As shown here, the balancing factors are interdependent, meaning that the calculation of one set requires the values of the other set, furthermore suggesting an iterative process until convergence is achieved. Thus, the practical approach to solving this formulation is to specify separate singly constrained models to both productions (Eq. 9) and to attractions (Eq. 10). The first one is obtained by making $\alpha_j = 1$ since in this case the columns are not being balanced. Similarly, the second one is obtained by making $\beta_i = 1$ since in this other case the rows are the ones not being balanced.

$$T_{ij} = P_i * \frac{A_j * f(t_{ij})}{\sum_{j} A_j * f(t_{ij})} \qquad \textbf{(Eq. 9)}$$

$$T_{ij} = A_j * \frac{P_i * f(t_{ij})}{\sum_{i} P_i * f(t_{ij})} \qquad \textbf{(Eq. 10)}$$

The solution for the doubly constrained model can then be converged upon by iteratively applying Eq. 9 to balance the productions (rows), and Eq. 10 to balance attractions (columns).

Transportation networks

In order to perform trip distribution, a roadway network needs to be developed for each urban area selected. This network is a simplified version of the current roadway infrastructure layout, including only the main arterials, from freeways to collector roads. Local streets are modeled by artificial links called connectors, which allow for the channeling of flows between the zones (zone centroids) and the network system. The networks were drawn from the maps of the selected urban areas, and organized in a roadway GIS. Figure 6 shows such primary roadway network developed for Hermosillo. Appendix 2 shows the roadway network for the rest of the urban areas selected.

Each link in the network was initially provided with attributes of functional class (generic type of infrastructure facility), and direction of flow. This information was gathered from visits to the selected urban areas through visual reconnaissance and characterization (smaller urban areas), and by interviewing local people and transportation related officials. From this information, a second set of network link attributes was provided based on average conditions developed for the Ciudad Juárez case study. This information was link capacity and average daily speed, corresponding to functional class and area type where individual links are located, as depicted in Table 5. Link travel time was then computed using the assigned link speed.

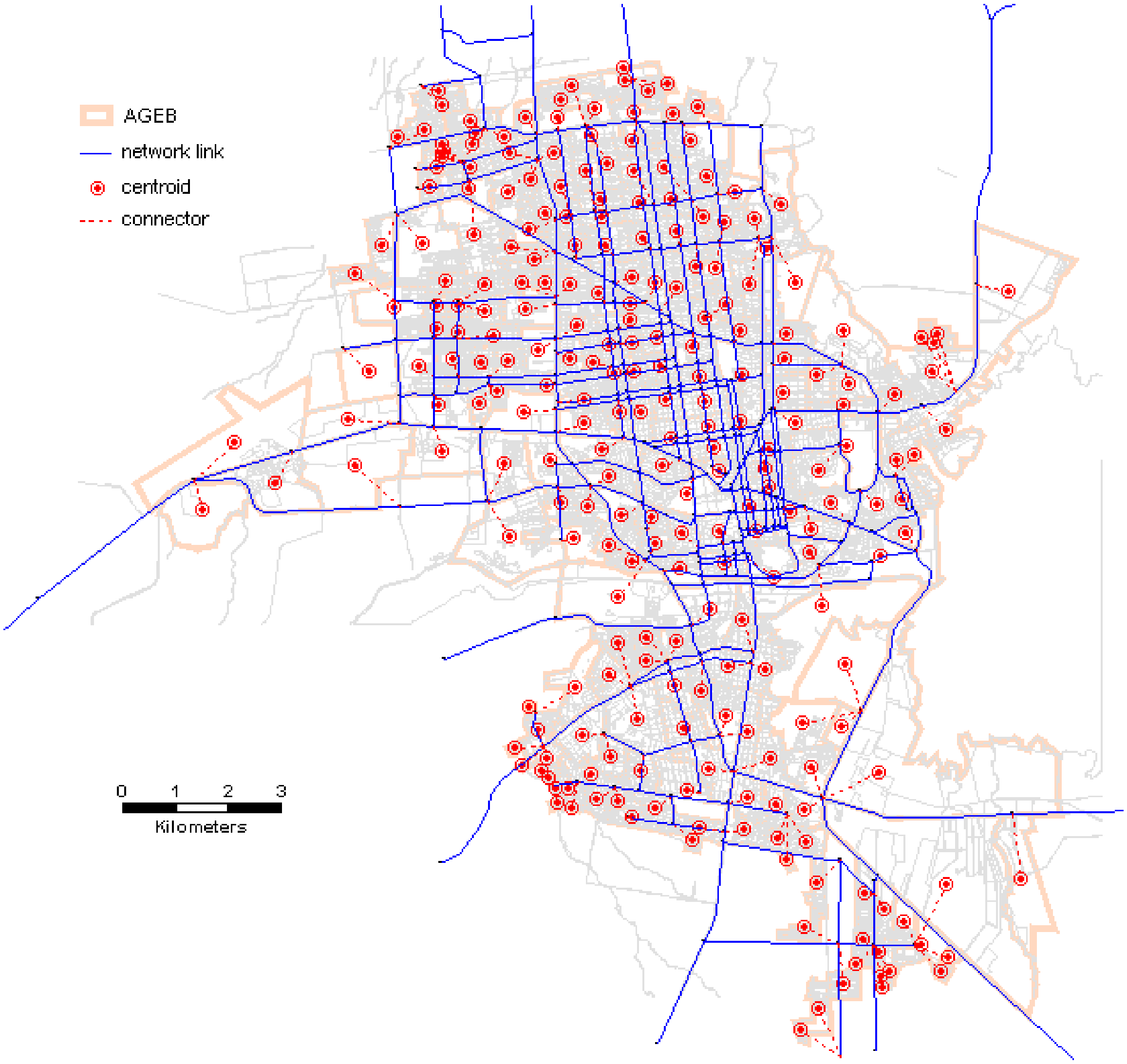


Figure 6. Example of roadway network model for Hermosillo.

Table 8. Speed and capacity (daily per lane) lookup table developed for Juárez.

Speed (mph) Capacity (vpl)		Area Type			
		CBD (1)	Urban (2)	Suburban (3)	Rural (4)
Functional Classification	Conn (0)	15 30000	15 30000	25 30000	35 30000
	Expy (3)	32 13100	32 13100	29 11750	36 10250
	PartD (4)	12 8350	12 8350	24 7500	31 6250
	PartU (5)	12 7500	12 7500	23 6800	37 5600
	MartD (6)	11 7250	11 7250	19 6500	29 4050
	MartU (7)	12 6600	12 6600	20 5950	31 3750
	MartUnp (8)	11 6200	11 6200	17 5550	28 3350
	Ramp (12)	20 18000	20 18000	18 18000	34 18000

Roadway networks are needed at this stage of the modeling process mainly to establish travel times between zones, since this will feed into the gravity-model evaluation. Using the network travel times, skim matrices were developed for all the urban areas. These skim matrices are matrices depicting the shortest travel time (in minutes) between all zones or AGEBs in the study area.

Evaluation of gravity model

The end result of the gravity-model estimation-calibration process, is the definition of the impedance function (the $f(t_{ij})$ term). For the Juárez case study, doubly-constrained gravity models were estimated and calibrated for the four trip purposes, yielding impedance functions in the form of friction factor (FF) tables. Under the current project, these FF tables were borrowed to evaluate gravity models for each of the selected urban areas, using the corresponding set of skim matrices and P-A tables. The result of this evaluation, was the development of trip distribution P-A matrices by trip purpose, for each of the selected urban areas.
The FF tables for each trip purpose are shown in Appendix 3.

Development of vehicle-trip OD matrices

As a final task of the trip distribution process, the all-mode person-trip P-A matrices needed to be converted into vehicle-trip O-D matrices.

First, this requires the application of mode shares (specifically AUTO mode), to the total number of person-trips by trip purpose.

Secondly, person-trips on AUTO need to be converted into vehicle-trips, by applying a passenger occupancy rate to the person-trip figure.
From the Juárez research, these AUTO shares and occupancy rates were observed as follows:

	person-trip AUTO share	average veh occupancy
HBW purpose	57.7%	1.25 pax/veh
HBO purpose	44.4%	1.87 pax/veh
NHB purpose	66.1%	1.72 pax/veh
TT purpose	100.0%	1.00 pax/veh

In the Juárez Case study, VKT from TRANSIT mode represents in the order of 2% of the total daily VKT, thus such vehicle activity has been emulated in the VKT mix at the emission modeling stages. The same approach has been followed for the initial six urban area categories.

For the specific case of Mexico City, a highly developed rapid mass transit system together with high population densities and restrictive automobile-use policies, conditions observed only in this mega urban area, result in a considerably different distribution of travel mode shares compared to other Mexican cities: only about 20% of all daily person-trips are done in AUTO mode, while close to 80% are done in TRANSIT mode, of which 66% represent the feeder bus share; thus a significant proportion of the daily internal combustion VKT is that from feeder buses (about 16% of daily VKT) (INEGI, 1994). Therefore in the case of Mexico City, the following shares and occupancy rates were used to develop its vehicle-trip OD matrix.

	person-trip AUTO share	average veh occupancy
HBW purpose	20.0%	1.25 pax/veh
HBO purpose	20.0%	1.87 pax/veh
NHB purpose	20.0%	1.72 pax/veh
TT purpose	100.0%	1.00 pax/veh

	person-trip feeder bus share	average veh occupancy
HBW, HBO and NHB purposes	66.0%	25.0 pax/veh

Vehicle occupancies are those observed in the Juárez case study.

Finally, in addition to the four generic trip purposes characterizing local (internal to the area) trips, an additional trip purpose was added at this stage, depicting external trips (EXT). This trip purpose actually includes all external-external and external-local trips, that is, trips that have at least one of their trip-ends outside of the study area. In order to develop the corresponding O-D matrix, for the current project the EXT trip purpose has been estimated as 5% percent of the total local non-transit vehicle-trip volume, which is the observed relationship in the Juárez case study. Table 9 presents a summary of daily vehicle-trips estimated for the selected urban areas.

Table 9. Summary of daily vehicle-trips estimated for the selected urban areas.

	Castaños	Río Bravo	Ensenada	Hermosillo	Juárez (base 96)	Monterrey	México City
HBW	3,732	16,327	45,136	121,002	214,029	616,144	1,394,426
HBO	9,742	43,040	119,031	319,211	549,677	1,625,773	5,089,242
NHB	3,261	14,105	39,017	104,490	189,881	532,541	1,113,013
TT	937	3,915	10,206	28,646	50,964	155,777	807,778
EXT	884	3,869	10,670	28,667	50,228	146,512	349,675
TOTAL	**18,555**	**81,256**	**224,060**	**602,017**	**1,054,778**	**3,076,746**	**8,754,134**

IV. Traffic Assignment

The final step in the travel demand modeling process and traffic congestion estimation is traffic assignment. In this step, the final OD vehicle-trip matrix for each urban area was assigned to the corresponding network system, using a user-equilibrium (UE) algorithm. Such algorithm assigns volumes to the network links, and through iteration balances congestion levels between similar cost (time) alternatives. The process involves re-computation of travel speeds to account for congestion levels as traffic volumes accumulate. The result of this step yielded "loaded" networks for the selected urban areas with traffic volumes and speeds at each of the links of the network. Figure 7 shows a thematic map of the loaded network obtained for Hermosillo. Appendix 4 shows similar loaded networks for the rest of the urban areas selected.

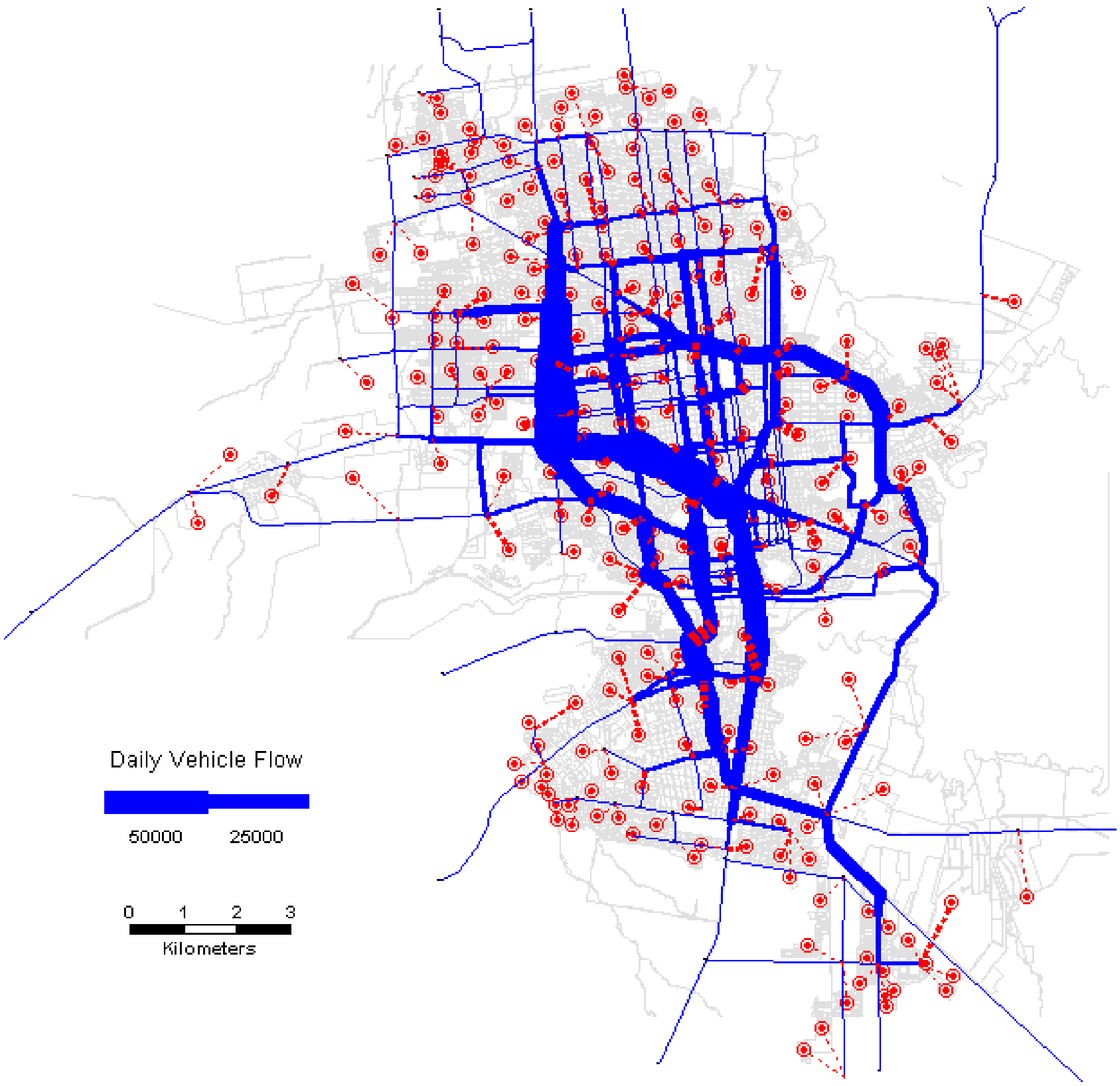


Figure 7. Example of a loaded roadway network for Hermosillo.

In future stages of the Mexico's NEI project, this information will be used to estimate on-road mobile source emissions by link, as well as aggregated by urban area.

Estimation of VKT

Vehicle-Kilometers-Traveled (VKT) by link were estimated simply by multiplying each link's daily traffic volume, times the corresponding link's length in kilometers. Adding the VKT-by-link of all the links in the roadway network provides the total VKT of the urban area. Table 10 provides a summary of VKT estimated for the selected urban areas, as well as an estimation of the per-capita VKT.

Table 10. Summary of VKT for the selected urban areas.

Category	Name	Population	Total VKT	per capita VKT
a	Castaños (1999)	19,586	38,162	1.9
b	Río Bravo (1999)	81,821	129,278	1.6
c	Ensenada (1999)	213,304	926,922	4.3
d	Hermosillo (1999)	598,703	3,140,586	5.2
e	Ciudad Juárez (1996 ref model)	1,065,000	6,579,080	6.2
f	Monterrey metro area (1999)	3,255,739	30,693,199	9.4
g	México City metro area (1999)	16,660,173	104,859,418	6.3

From Table 10 it is somewhat evident that as urban areas grow, so does the per-capita VKT. The exception seems to be in this study, the case with Castaños and Mexico City. The Castaños case is being viewed with some caution, since as previously stated, Castaños was the only urban area for which employment totals and location had to be assumed. Thus it would seem safe to lump the first two categories of urban area sizes into one, and for the case of per capita VKT, consider using the value of 1.9 as a conservative approach. For Mexico City, the significant importance of transit use clearly contributes to reduce the vehicle activity, which as a per capita total results in a lower value than Monterrey's. Still, Mexico City's overall total VKT is the highest of any Mexican urban area.

V. On-road mobile source emissions

Having completed the travel demand modeling part of the project, the final task requires converting the resulting daily vehicle activity (motorized travel) into total daily on-road mobile source emissions, for each of the urban area size categories. This information in turn, expressed as per-capita totals, can be applied to population nodes across Mexico to estimate mobile source emissions for the country.

Base emission rates

Emission rates in grams/mile-of-travel (or grams/VMT) for VOC, CO, NOx, $PM_{2.5}$, PM_{10}, SO_2, and SO_4 have been obtained through the use of MOBILE6-Mexico, a software developed originally as MOBILE6 by the U. S. Environmental Protection Agency for use in the United States, but modified into a Mexican version to fit this country's vehicle fleet conditions.

In an initial attempt to cover a wide range of conditions taking place along Mexican roadways, emission rates were developed for vehicle speeds going from 3 to 65 mph, and for a range of temperatures depicting average ambient conditions at different time-of-day periods, generic seasons of the year, and different geographic locations across Mexico. Based on preliminary temperature information obtained from INEGI (INEGI, 2000c) and limited weather data from some cities in Mexico, the following matrix of temperatures was suggested to be used as input to MOBILE6-Mexico runs in combination with the recommended range of speeds.

Table 11. Array of temperatures used to develop emission rates

time-of-day period	**condition A** North Winter High elevation [ºF]	**condition B** North Winter Low elevation [ºF]	**condition C** North Summer High elevation [ºF]	**condition D** North Summer Low elevation [ºF]	**condition E** South Winter High elevation [ºF]	**condition F** South Winter Low elevation [ºF]	**condition G** South Summer High elevation [ºF]	**condition H** South Summer Low elevation [ºF]
1	40º	55º	72º	84º	54º	66º	78º	91º
2	50º	65º	82º	94º	64º	76º	88º	101º
3	60º	75º	92º	104º	69º	81º	93º	106º
4	30º	45º	62º	74º	49º	56º	73º	86º

The ''High elevation'' condition was considered at altitudes equal or higher than 1,400m over sea level. The ''North'' location condition was considered at latitudes of 220,000 or higher.

An example MOBILE6-Mexico input file is shown in Appendix 5. As shown in Table 11, four time-of-day periods where established depicting traffic congestion patterns using the Ciudad Juárez case study. These time-of-day periods are:

period 1	7 am to 9 am
period 2	9 am to 4 pm
period 3	4 pm to 8 pm
period 4	8 pm to 7 am

Emissions by link

Having developed the base emission rates for the resulting combinations of speeds and temperatures, these were assigned to each link in the transportation networks, based on the prevailing "congested" speed at a specific point in time during the day. For this, the daily non-directional traffic and 24-hour average speeds assigned to each link in the travel models needed to be converted to time-of-day directional traffic and time-of-day directional speeds. To do this a special computer program labeled PrepinPlus was coded in Visual Basic (VB) language, following the methodology developed by the Texas Transportation Institute on its software PREPIN. The following sequence summarizes the process, which needs to be done for each of the four time-of-day periods:

a) The 24-hour non-directional traffic assigned to each network link is distributed over the four time-of-day periods, based on information from ground counts. For Mexican roadway networks the daily traffic volumes have been distributed as follows, based on the Juárez case study:

period 1	9.8%	over a 2-hour period
period 2	39.8%	over a 7-hour period
period 3	26.0%	over a 4-hour period
period 4	24.4%	over an 11-hour period
	100.0%	

b) To establish the directional split, the period non-directional traffic volume on each link is then applied a factor, which depends on the specific time-of-day period being analyzed. These factors vary also depending on the area type and functional classification of the roadway. Table 12 shows the average directional factors used for the AB link direction; the complement to 1 is applied to the BA direction of each link. At this point then every link in the network has directional traffic volumes for the time-of-day period being evaluated.

Table 12. Directional split factors used for Juárez.

period 1

		Functional classification												
		0	1	2	3	4	5	6	7	8	9	10	11	12
Area Type	1	0.540	0.650	0.500	0.650	0.650	0.650	0.580	0.580	0.645	0.645	0.500	0.500	0.500
	2	0.540	0.650	0.500	0.650	0.650	0.650	0.580	0.580	0.645	0.645	0.500	0.500	0.500
	3	0.870	0.600	0.500	0.600	0.600	0.600	0.590	0.590	0.630	0.630	0.500	0.500	0.500
	4	0.760	0.620	0.630	0.665	0.665	0.665	0.650	0.650	0.738	0.738	0.630	0.630	0.630

periods 2 and 4

		Functional classification												
		0	1	2	3	4	5	6	7	8	9	10	11	12
Area Type	1	0.540	0.550	0.510	0.550	0.550	0.550	0.550	0.550	0.545	0.545	0.510	0.510	0.510
	2	0.540	0.550	0.510	0.550	0.550	0.550	0.550	0.550	0.545	0.545	0.510	0.510	0.510
	3	0.540	0.540	0.510	0.540	0.540	0.540	0.550	0.550	0.530	0.530	0.510	0.510	0.510
	4	0.540	0.565	0.510	0.565	0.565	0.565	0.565	0.565	0.555	0.555	0.510	0.510	0.510

period 3

		Functional classification												
		0	1	2	3	4	5	6	7	8	9	10	11	12
Area Type	1	0.550	0.620	0.540	0.620	0.620	0.620	0.520	0.520	0.575	0.575	0.540	0.540	0.540
	2	0.550	0.620	0.540	0.620	0.620	0.620	0.520	0.520	0.575	0.575	0.540	0.540	0.540
	3	0.720	0.590	0.540	0.590	0.590	0.590	0.530	0.530	0.645	0.645	0.540	0.540	0.540
	4	0.715	0.615	0.665	0.615	0.615	0.615	0.645	0.645	0.648	0.648	0.665	0.665	0.665

c) Next, the average directional 24-hour link capacities provided as attributes of the roadway network are converted into directional hourly capacities. This is done through another set of conversion factors that also depend on the area type and functional classification of the link. Table 13 shows the factors used; these remain constant during the day.

Table 13. Conversion factors for 24-hour to hourly capacities.

		Functional classification												
		0	1	2	3	4	5	6	7	8	9	10	11	12
Area Type	1	N/A	0.063	0.104	0.063	0.066	0.066	0.076	0.076	0.073	0.070	0.070	0.066	0.061
	2	N/A	0.063	0.104	0.063	0.066	0.066	0.076	0.076	0.073	0.070	0.070	0.066	0.061
	3	N/A	0.077	0.081	0.077	0.080	0.081	0.092	0.092	0.086	0.083	0.083	0.080	0.067
	4	N/A	0.106	0.166	0.106	0.116	0.121	0.173	0.167	0.164	0.159	0.159	0.112	0.078

By multiplying the directional hourly capacities by the hours in each period, these are then turned into directional link capacities for the entire time-of-day period.
Having established both directional traffic volume and capacity for each link, for a specific time-of-day period, the link's v/c ratio on each direction can be computed.

d) To establish the directional time-of-day speed, the DFW algorithm in the PREPIN methodology was used. For this algorithm the free-flow speed for each link needs to be established, and for that purpose Table 14 provide average values depending on the link's specific area type and functional classification. For each link, this free-flow speed goes into the DFW algorithm together with the average 24-hour speed, and the directional v/c ratio, thus yielding the directional congested speed.

Table 14. Free-flow speeds in mph.

		Functional classification												
		0	1	2	3	4	5	6	7	8	9	10	11	12
Area Type	1	15.00	50.00	55.00	50.00	11.90	11.90	11.90	11.90	11.90	11.90	11.90	11.90	16.90
	2	15.00	50.00	55.00	50.00	11.90	11.90	11.90	11.90	11.90	11.90	11.90	11.90	16.90
	3	25.00	50.00	55.00	50.00	25.40	25.40	20.00	20.00	19.40	19.40	25.40	25.40	30.40
	4	35.00	51.00	57.00	51.00	36.40	36.40	31.30	31.30	30.00	30.00	30.00	36.40	41.40

Converting link congestion into emissions by-link

The directional speed on each link (established for specific time-of-day periods) is then used to establish the link's emissions rate to use for VOC, CO, NOx, $PM_{2.5}$, PM_{10}, SO_2, and SO_4. These MOBILE6-Mexico rates are provided as a lookup table on the VB code and used to assign the resulting rates to each link. Appendix 6 shows an example of the on-road mobile source emission rates developed for the Mexico NEI project.

Having established the emission rates for each link, these are then multiplied by the link's length and traffic volume (i.e. link VMT) in the period to obtain the link's emissions concentration per time-of-day.

Per capita emissions by urban area category

PrepinPlus code was run for the traffic loaded networks of each of the urban area size categories, for each of the seasonal and geographical temperatures.

The resulting emissions-by-link were added for the four time-of-day periods to establish daily emissions-by-link. Finally, these total daily emissions-by-link were aggregated for each of the urban areas modeled, and the result divided by the corresponding urban area population (1999) to establish per capita mobile source emissions; these per capita emissions are available by pollutant as well by vehicle class (according to EPA's 28 categories).

Annual emissions estimation for northern Mexico States

Depending on the geographic location (latitude and elevation) of each population node in Mexico, corresponding daily per capita emission values were selected. These values were then multiplied by corresponding population totals and by the number of days for each of the generic seasons of winter and summer. In this regard, each generic season was considered to have 182.5 days.
This information was organized in a geographic information system (GIS) developed by locality for the entire country.

The annual on-road mobile source emissions estimated for Mexico are summarized by state on Table 15.

Table 15. Annual on-road mobile source emissions for Mexico (1999)

	Pop 99	VOC [Tm/year]	CO [Tm/year]	NOx [Tm/year]	$PM_{2.5}$ [Tm/year]	PM_{10} [Tm/year]	SO_2 [Tm/year]	SO_4 [Tm/year]
Aguascalientes	732,911	4,742	40,817	3,680	89	108	86	6
Baja California	3,275,792	24,066	183,989	19,763	467	567	448	34
Baja California	334,803	1,331	10,109	1,086	26	32	25	2
Campeche	480,178	2,266	16,738	1,769	43	53	42	3
Coahuila	2,025,242	11,789	98,090	9,647	229	278	220	16
Colima	453,629	1,800	13,156	1,385	33	41	32	2
Chiapas	1,775,865	7,404	56,368	5,817	141	171	135	10
Chihuahua	3,130,902	20,526	174,695	16,561	392	476	376	28
DF	8,538,130	88,048	733,789	61,927	1,384	1,681	1,329	101
Durango	928,936	5,442	48,076	4,437	106	129	102	8
Guanajuato	3,077,805	17,741	150,530	13,481	326	396	315	24
Guerrero	1,688,245	7,978	59,997	6,304	152	185	146	11
Hidalgo	1,138,956	4,231	35,861	3,267	79	96	76	6
Jalisco	5,259,730	56,019	466,976	40,126	915	1,111	878	66
México	10,910,080	89,544	750,256	64,317	1,469	1,785	1,410	106
Michoacán	2,586,867	10,327	86,286	7,915	192	233	184	14
Morelos	1,293,717	6,531	53,948	5,100	124	151	119	9
Nayarit	584,833	2,698	20,339	2,161	52	63	50	4
Nuevo León	3,516,646	45,841	341,522	35,218	780	948	749	57
Oaxaca	1,922,764	6,838	56,158	5,355	130	158	125	9
Puebla	3,491,980	18,168	153,294	13,866	337	409	323	24
Querétaro	918,213	4,814	41,109	3,714	90	109	86	6
Quintana Roo	1,040,113	6,498	48,375	5,116	122	148	117	9
San Luis Potos	1,351,645	7,391	67,072	5,890	141	171	135	10
Sinaloa	1,677,712	8,513	65,686	7,096	169	205	162	12
Sonora	1,830,502	8,518	65,317	7,014	167	203	160	12
Tabasco	970,008	4,026	30,083	3,186	76	93	73	5
Tamaulipas	2,306,242	13,411	103,356	11,157	264	321	254	19
Tlaxcala	755,206	3,950	33,774	3,051	74	90	71	5
Veracruz	4,220,812	19,832	151,375	15,611	375	455	360	27
Yucatán	1,382,105	7,061	52,860	5,601	134	163	129	10
Zacatecas	731,036	2,468	22,854	1,947	47	58	45	3
TOTAL	74,331,605	519,812	4,232,855	392,565	9,125	11,087	8,762	658

Appendix 1

Maps with zone (AGEB) structures for selected urban areas

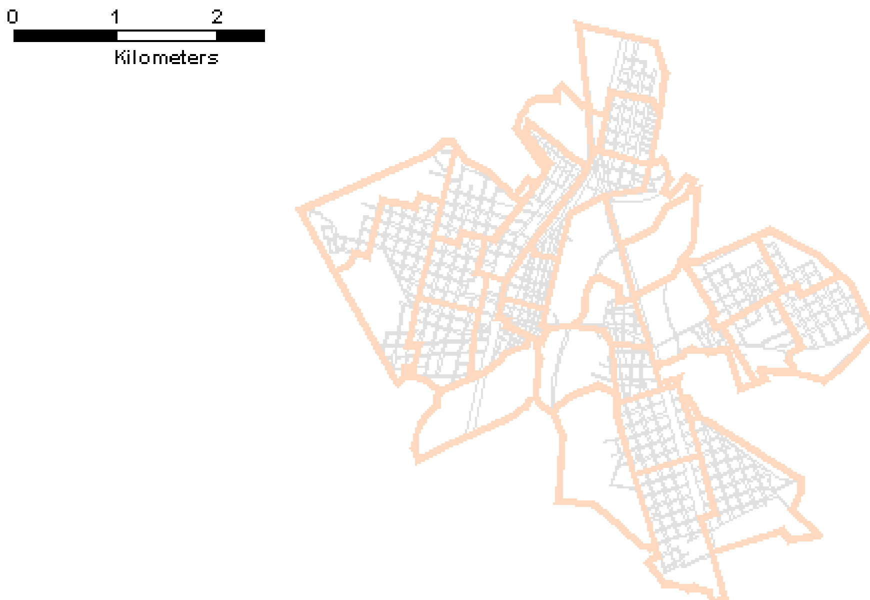


Figure A1. Zone (AGEB) structure for Castaños.

Figure A2. Zone (AGEB) structure for Río Bravo.

Figure A3. Zone (AGEB) structure for Ensenada.

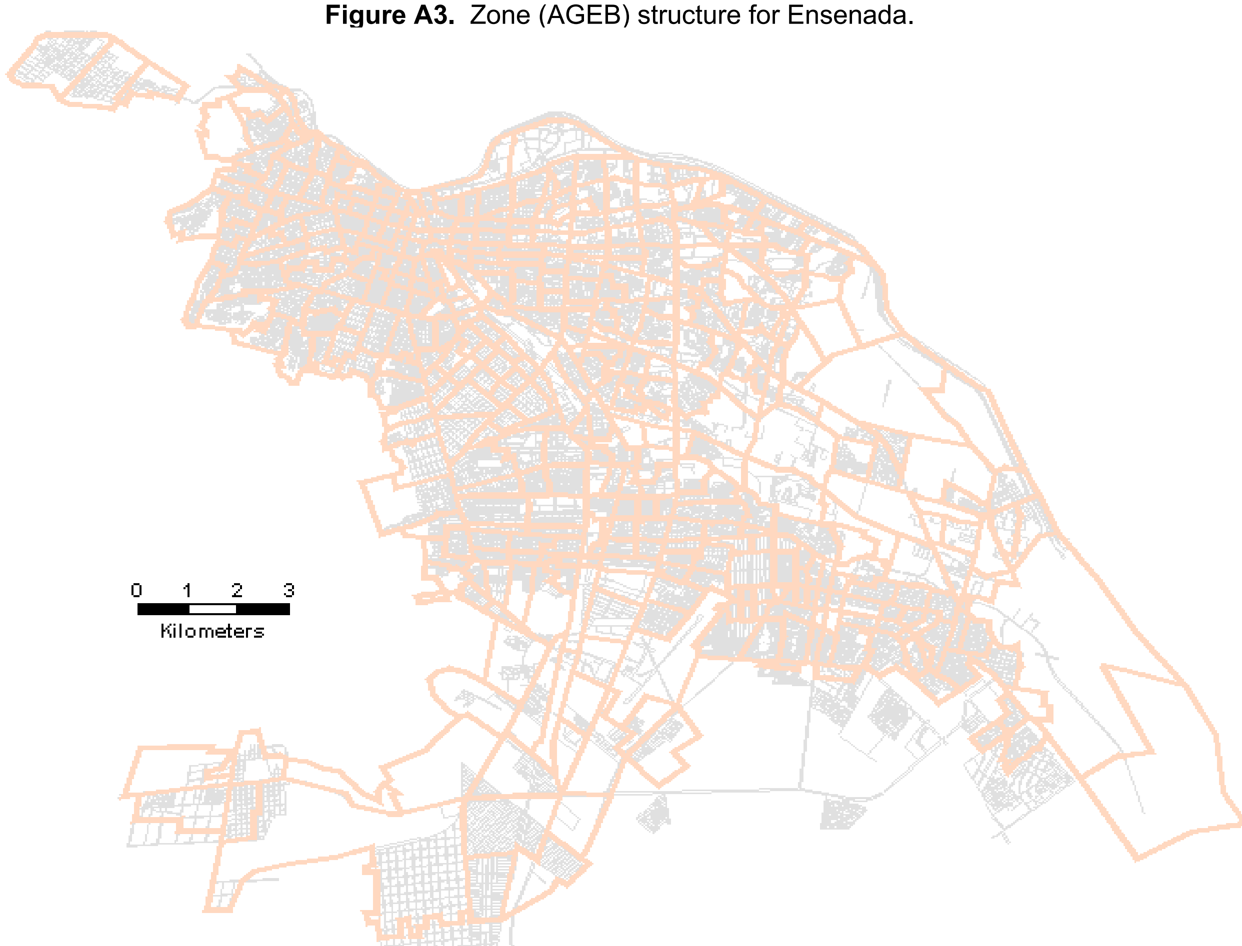


Figure A4. Zone structure for Ciudad Juárez (not based on AGEBs).

Figure A5. Zone (AGEB) structure for Monterrey metropolitan area.

Appendix 2

Maps of roadway network models for selected urban areas

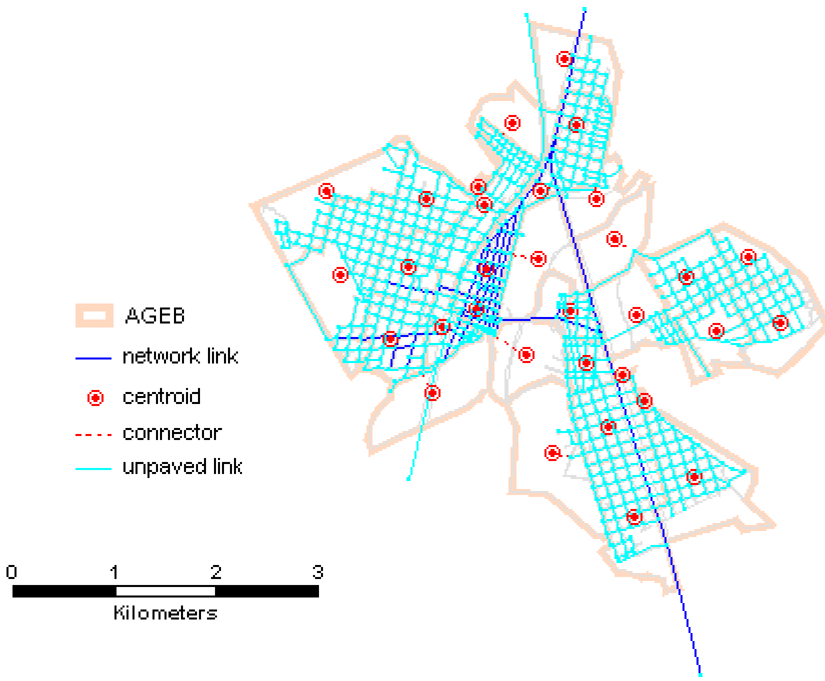


Figure B1. Roadway network model for Castaños.

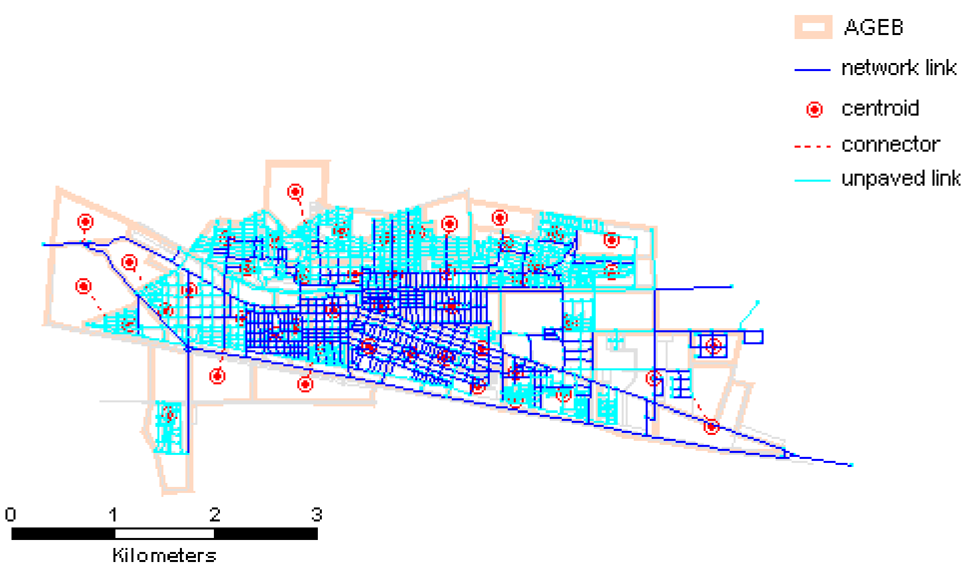


Figure B2. Roadway network model for Río Bravo.

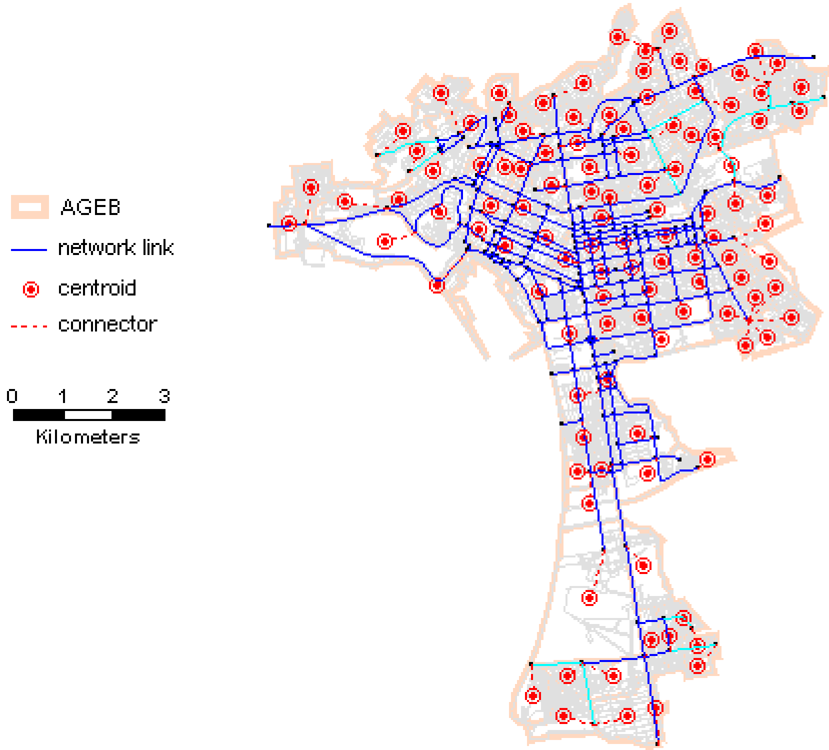


Figure B3. Roadway network model for Ensenada.

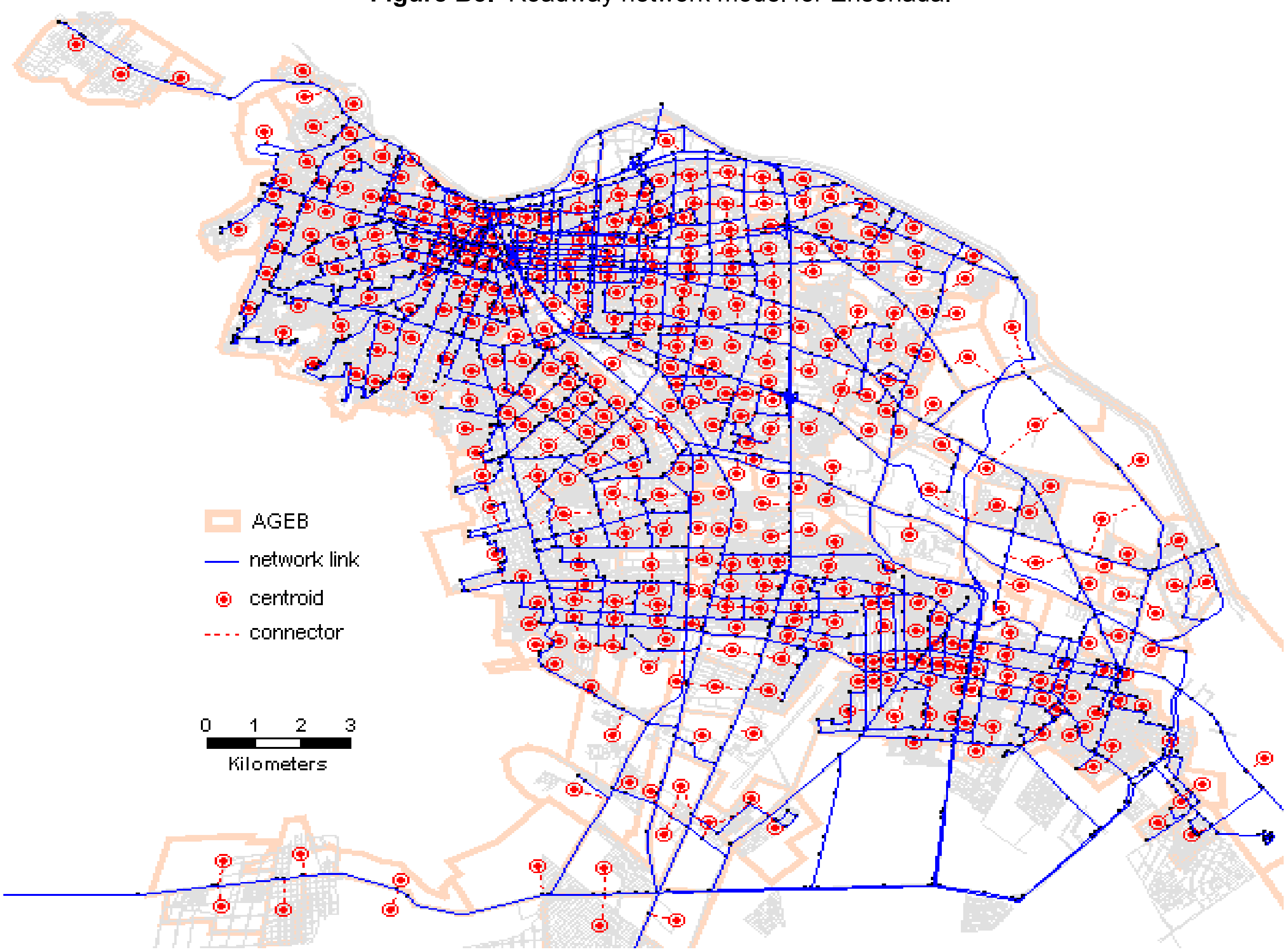


Figure B4. Roadway network model for Ciudad Juárez.

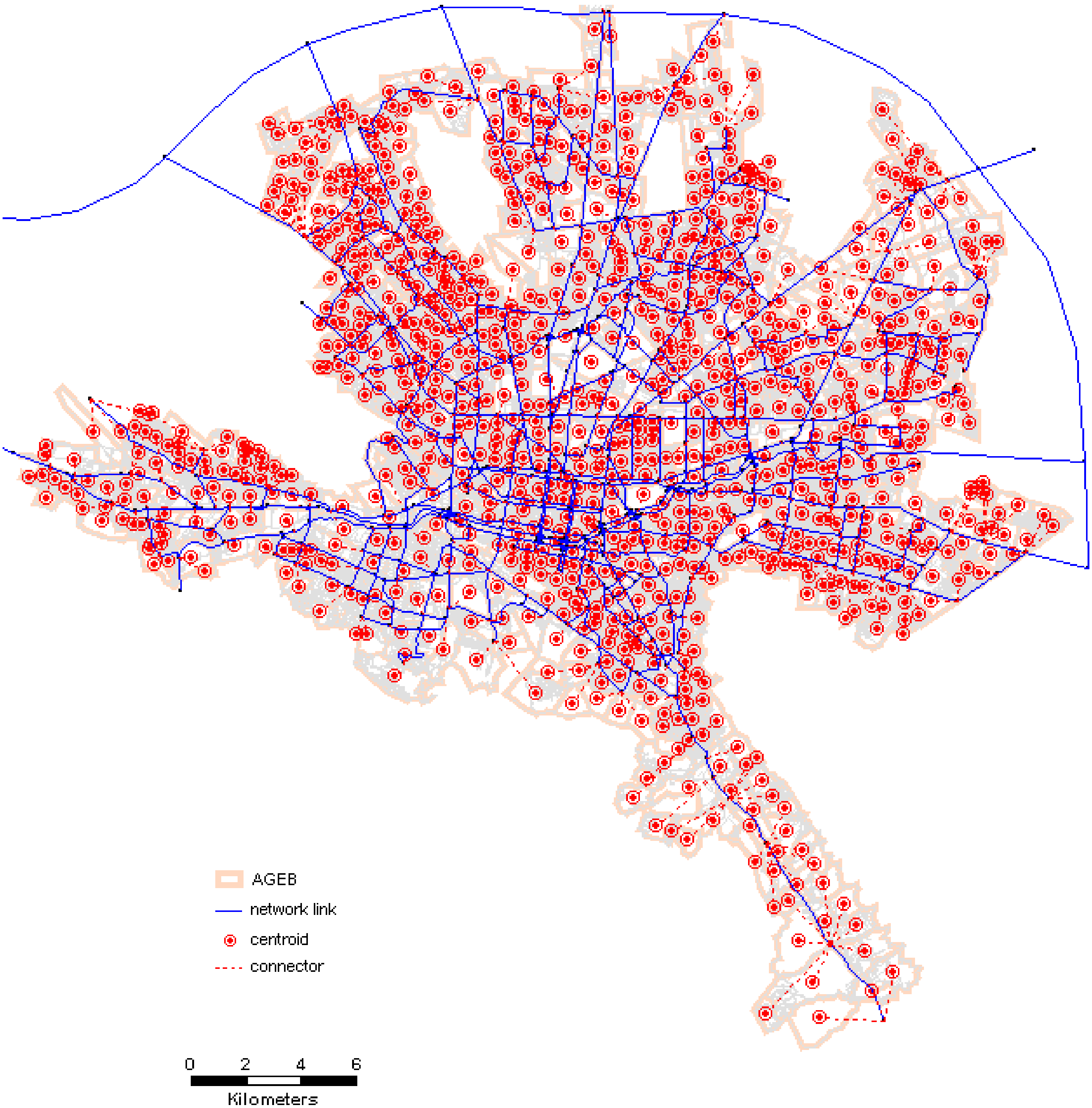


Figure B5. Roadway network model for Monterrey metropolitan area.

Appendix 3

Friction Factor tables calibrated for Ciudad Juárez

HBW friction factors

MIN	FFADJ
0	70.0000
1	59.4000
2	58.4000
3	55.0000
4	48.5071
5	44.3000
6	41.1309
7	37.8338
8	35.6000
9	31.9673
10	29.5000
11	27.7000
12	25.8000
13	23.7000
14	22.2000
15	20.8000
16	19.8000
17	18.8038
18	17.8000
19	17.2000
20	16.3000
21	15.5000
22	14.6000
23	13.8000
24	13.0000
25	12.2000
26	11.7401
27	10.9000
28	10.4000
29	9.9000
30	9.3000
31	8.5435
32	7.7000
33	6.9000
34	6.4000
35	5.7000
36	5.5000
37	5.0000
38	4.6909
39	4.3000
40	4.0000
41	3.8000
42	3.6000
43	3.3000
44	3.2000
45	3.0000
46	2.9000
47	2.7000
48	2.7000
49	2.7000
50	2.7000
51	2.4860
52	2.5000
53	2.5000
54	2.4000
55	2.3000
56	2.3000
57	2.2000
58	2.0000
59	2.0000
60	1.8000
61	1.8000
62	1.5000
63	1.4000
64	1.3000
65	1.3000

HBO friction factors

MIN	FFADJ
0	1700.0000
1	1219.2475
2	753.0000
3	526.5936
4	353.9208
5	234.1539
6	172.1519
7	142.0000
8	117.5805
9	96.3526
10	79.1969
11	66.0000
12	58.0000
13	51.8285
14	48.0000
15	43.0000
16	39.4995
17	36.0000
18	34.0000
19	32.0000
20	30.0000
21	28.5725
22	27.0000
23	25.0105
24	23.0000
25	21.0000
26	19.5000
27	18.0000
28	17.0532
29	16.0000
30	15.0000
31	14.0000
32	13.0000
33	12.0000
34	11.0000
35	10.0000
36	9.0000
37	8.0000
38	7.0000
39	6.0000
40	5.0000
41	4.5000
42	4.0000
43	3.5000
44	3.0000
45	2.5000
46	2.0000
47	1.5000
48	1.0000
49	0.7500
50	0.5000
51	0.2500
52	0.0000
53	0.0000
54	0.0000
55	0.0000
56	0.0000
57	0.0000
58	0.0000
59	0.0000
60	0.0000
61	0.0000
62	0.0000
63	0.0000
64	0.0000
65	0.0000

NHB friction factors

MIN	FFADJ
0	800.0000
1	644.8582
2	457.0000
3	343.0000
4	255.0000
5	167.2963
6	122.0000
7	93.7080
8	76.0000
9	70.0000
10	65.0000
11	60.0000
12	55.0000
13	50.0000
14	45.0000
15	40.0000
16	36.0000
17	32.0000
18	29.0000
19	26.0000
20	23.0000
21	20.0000
22	18.0000
23	16.0000
24	15.0000
25	14.0000
26	13.0000
27	12.0000
28	11.0000
29	10.5000
30	10.0000
31	9.5000
32	9.0000
33	8.5000
34	8.0000
35	7.5000
36	7.0000
37	6.5000
38	6.0000
39	5.5000
40	5.0000
41	4.5000
42	4.0000
43	3.5000
44	3.0000
45	2.5000
46	2.0000
47	1.5000
48	1.0000
49	0.7500
50	0.5000
51	0.2500
52	0.0000
53	0.0000
54	0.0000
55	0.0000
56	0.0000
57	0.0000
58	0.0000
59	0.0000
60	0.0000
61	0.0000
62	0.0000
63	0.0000
64	0.0000
65	0.0000

MIN	FFADJ
1	250.2112
2	224.8564
3	155.6587
4	124.3997
5	99.4737
6	82.9008
7	68.0463
8	55.8430
9	48.2878
10	38.9329
11	33.1706
12	27.1962
13	22.2751
14	18.6162
15	15.7832
16	13.4600
17	11.3764
18	10.0755
19	8.8308
20	7.6745
21	6.7468
22	6.0852
23	5.7020
24	5.1868
25	4.7752
26	4.4614
27	3.9908
28	3.6511
29	3.2476
30	2.9485
31	2.6267
32	2.2980
33	1.9572
34	1.1179
35	0.8041
36	0.6715
37	0.5123
38	0.2725
39	0.0001
40	0.0001
41	0.0001
42	0.0001
43	0.0000
44	0.0000
45	0.0000
46	0.0000
47	0.0000
48	0.0000
49	0.0000
50	0.0000
51	0.0000
52	0.0000
53	0.0000
54	0.0000
55	0.0000
56	0.0000
57	0.0000
58	0.0000
59	0.0000
60	0.0000
61	0.0000
62	0.0000
63	0.0000
64	0.0000
65	0.0000

Appendix 4

Maps of loaded roadway networks for selected urban areas

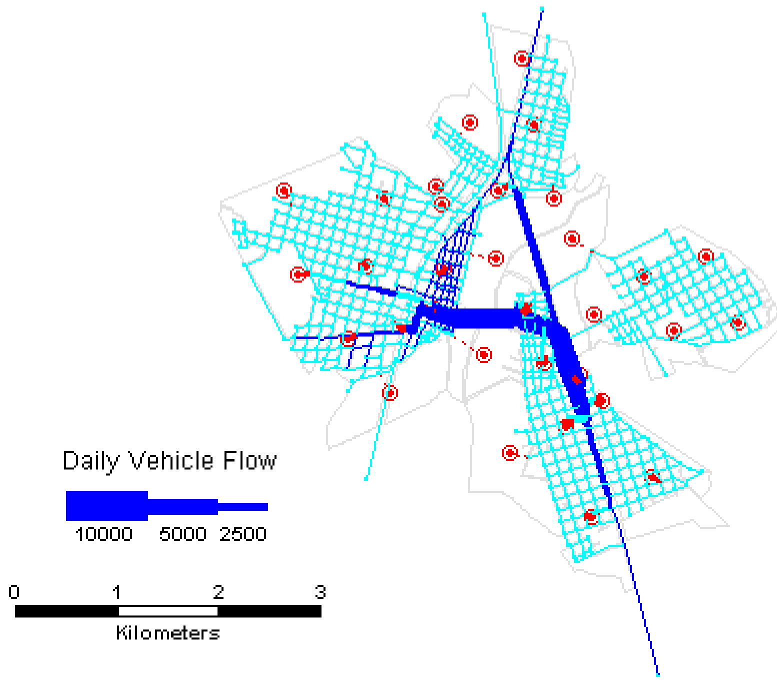


Figure D1. Loaded roadway network for Castaños.

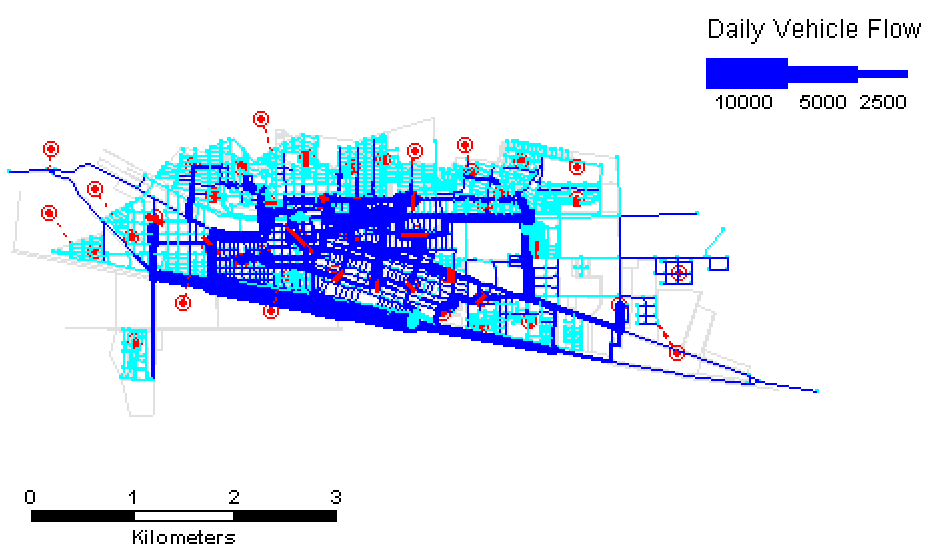


Figure D2. Loaded roadway network for Río Bravo.

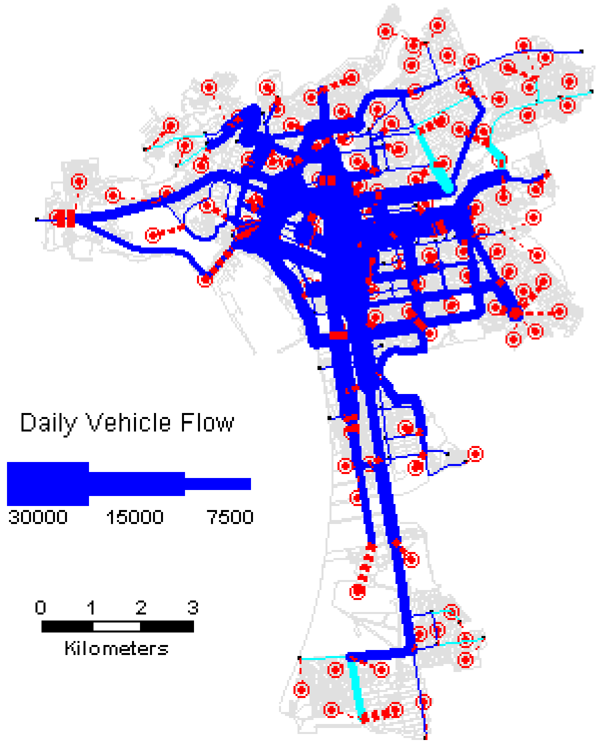


Figure D3. Loaded roadway network for Ensenada

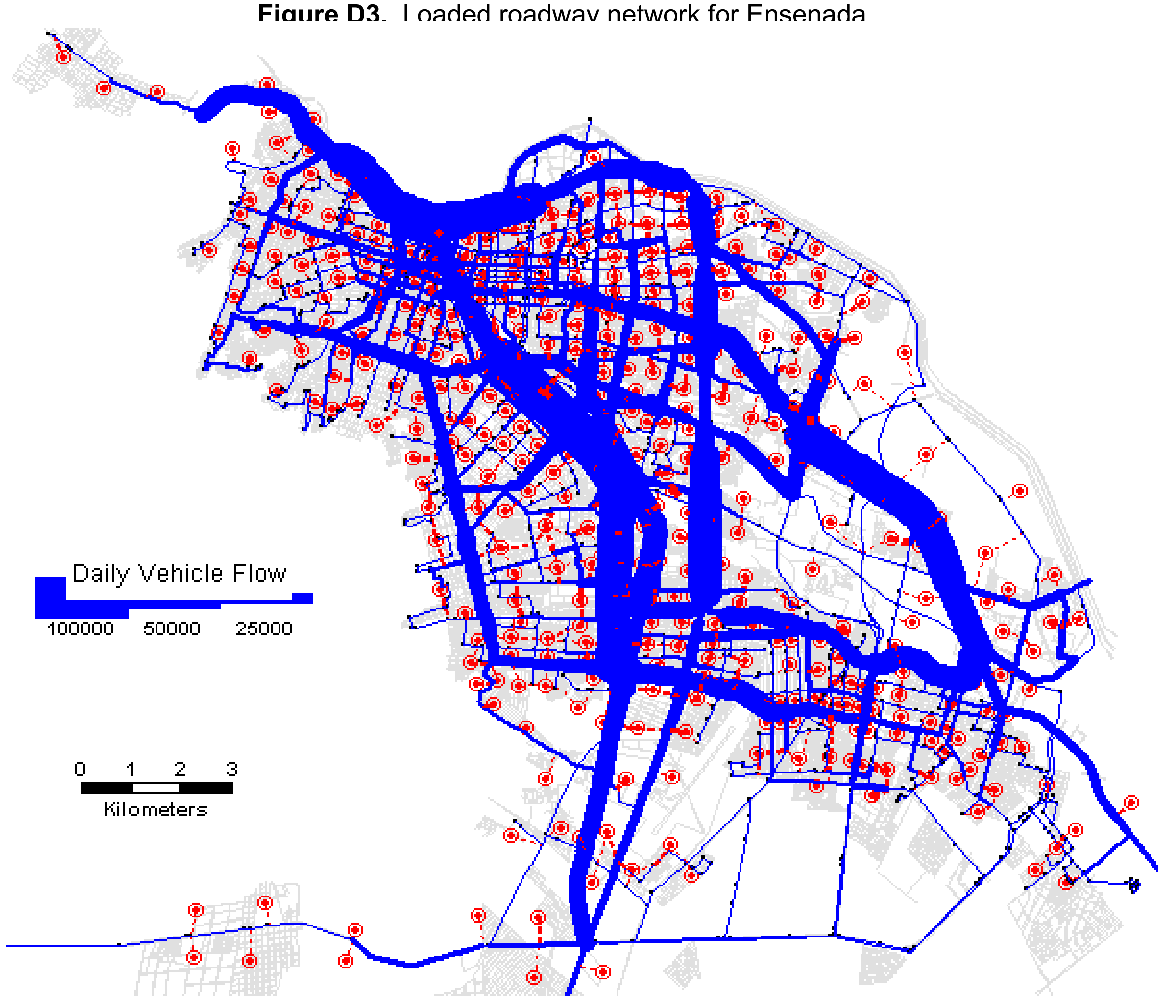


Figure D4. Loaded roadway network for Ciudad Juárez.

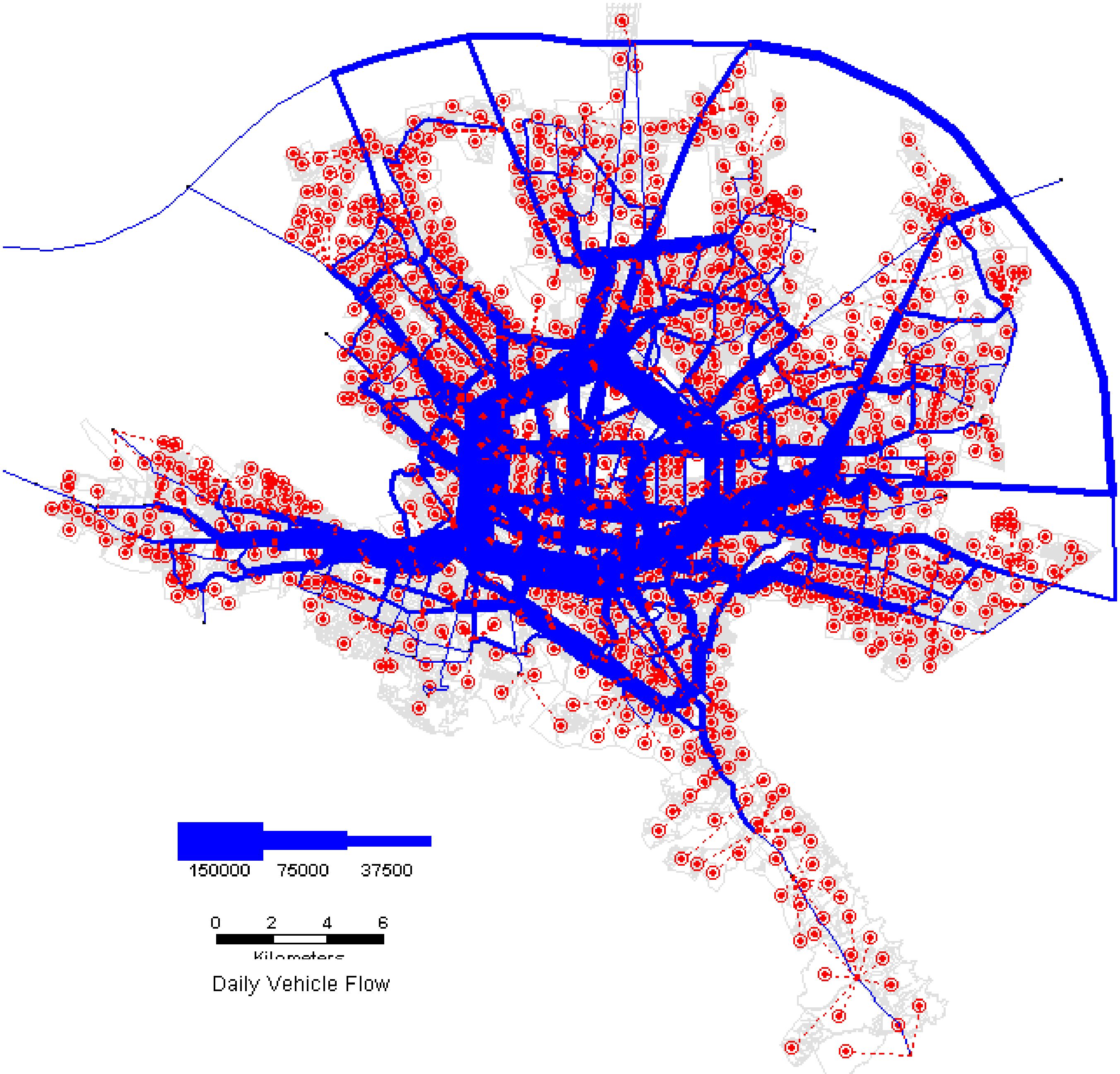


Figure D5. Loaded roadway network for Monterrey metropolitan area.

Appendix 5

Example input file for MOBILE6-Mexico (condition A, period1)

```
********************* Header Section ********************
MOBILE6 INPUT FILE
*Input file for daily VOC, CO, and NOx exhaust emissions for environment condition A

Input Extensions   : INTL EFS HI-EM TECHFRAC
SPREADSHEET        :
RUN DATA

********************** Run Section **********************

Express HC As VOC  :
Expand Exhaust     :
Expand Evap        :
FUEL RVP           : 08.0
MIN/MAX TEMP       : 40.0 40.0
REG DIST           : Mex_Regdata_1999.dat
MILE ACCUM RATE    : Mex_MAR.dat
NO HDCGPM          : *Req before "Basic EFS" to defeat g/bhp conv on HDV
Basic EFS          : Mex_Basic_EFS.dat
1981-93 LDG EFS    : Mex_8193_EFS.dat
94+ LDG Imp        : Mex_P94_Imp.dat
We Da Tri Len Di   : Mex_Trip_Leng_WeekDay.dat
We En Tri Len Di   : Mex_Trip_Leng_WeekEnd.dat

******************* Scenario Section ********************

SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  2
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
AVERAGE SPEED      :  3.0 arterial

SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  2
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
AVERAGE SPEED      :  4.0 arterial
.
.
.
.
SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  2
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
AVERAGE SPEED      :  64.0 arterial

SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  2
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
AVERAGE SPEED      : 65.0 arterial

********************** End of Run ********************
END OF RUN
```

```
********************* Header Section ********************
MOBILE6 INPUT FILE
*Input file for daily VOC evaporative emissions for environment condition A
*using average daily speeds for running losses

Input Extensions   : INTL EFS HI-EM TECHFRAC
SPREADSHEET        :
RUN DATA

********************** Run Section **********************
Express HC As VOC  :
Expand Exhaust     :
Expand Evap        :
FUEL RVP           : 08.0
MIN/MAX TEMP       : 30.0 60.0

INTL FLEET FILE    : MexFleet.inc

We Da Tri Len Di   : Mex_Trip_Leng_WeekDay.dat
We En Tri Len Di   : Mex_Trip_Leng_WeekEnd.dat

******************* Scenario Section ********************
SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  2
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
AVERAGE SPEED      : 10.0 arterial

SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  2
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
AVERAGE SPEED      : 11.0 arterial
.
.
.
.
SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  2
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
AVERAGE SPEED      : 39.0 arterial

SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  2
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
AVERAGE SPEED      : 40.0 arterial

*********************** End of Run *********************
END OF RUN
```

```
********************* Header Section ********************
MOBILE6 INPUT FILE
*Input file for PM10 emissions
*Temperature and altitude have no PM impact.  Speed only impacts SO4 and SO2
*PM is only minimally affected by speed (60mph speed difference shows 0.3% change in total PM emissions)
*This run is for all scenarios (a to h)
Input Extensions   : INTL EFS HI-EM TECHFRAC
PARTICULATES       :
SPREADSHEET        :
RUN DATA

********************** Run Section **********************
Express HC As VOC  :
Expand Exhaust     :
Expand Evap        :
FUEL RVP           : 08.0
MIN/MAX TEMP       : 80.0 80.0

INTL FLEET FILE    : MexFleet.inc

We Da Tri Len Di   : Mex_Trip_Leng_WeekDay.dat
We En Tri Len Di   : Mex_Trip_Leng_WeekEnd.dat

******************* Scenario Section ********************
SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  1
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 10.0
DIESEL SULFUR      : 300.0
AVERAGE SPEED      :  3.0 arterial

*********************** End of Run *********************
END OF RUN
```

```
********************* Header Section ********************
MOBILE6 INPUT FILE
*Input file for PM2.5 emissions
*Temperature and altitude have no PM impact.  Speed only impacts SO4 and SO2
*PM is only minimally affected by speed (60mph speed difference shows 0.3% change in total PM emissions)
*This run is for all scenarios (a to h)
Input Extensions   : INTL EFS HI-EM TECHFRAC
PARTICULATES       :
SPREADSHEET        :
RUN DATA

********************** Run Section **********************
Express HC As VOC  :
Expand Exhaust     :
Expand Evap        :
FUEL RVP           : 08.0
MIN/MAX TEMP       : 80.0 80.0

INTL FLEET FILE    : MexFleet.inc

We Da Tri Len Di   : Mex_Trip_Leng_WeekDay.dat
We En Tri Len Di   : Mex_Trip_Leng_WeekEnd.dat

******************* Scenario Section ********************
SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  1
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      :  2.5
DIESEL SULFUR      : 300.0
AVERAGE SPEED      :  3.0 arterial

*********************** End of Run **********************
END OF RUN
```

```
********************* Header Section ********************
MOBILE6 INPUT FILE
*Input file for SOx emissions
*Temperature and altitude have no PM impact.  Speed only impacts SO4 and SO2
*PM is only minimally affected by speed (60mph speed difference shows 0.3% change
*in total PM emissions)
*This run is for all scenarios (a to h)
Input Extensions   : INTL EFS HI-EM TECHFRAC
PARTICULATES       :
SPREADSHEET        :
RUN DATA

********************** Run Section **********************
Express HC As VOC  :
Expand Exhaust     :
Expand Evap        :
FUEL RVP           : 08.0
MIN/MAX TEMP       : 80.0 80.0

INTL FLEET FILE    : MexFleet.inc

We Da Tri Len Di   : Mex_Trip_Leng_WeekDay.dat
We En Tri Len Di   : Mex_Trip_Leng_WeekEnd.dat

******************* Scenario Section ********************
SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  1
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 10.0
DIESEL SULFUR      : 300.0
AVERAGE SPEED      :  3.0 arterial
.
.
.
.
SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  1
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 10.0
DIESEL SULFUR      : 300.0
AVERAGE SPEED      : 64.0 arterial

SCENARIO RECORD    :
CALENDAR YEAR      : 1999
ALTITUDE           :  1
SOAK DISTRIBUTION  : Mex_Soak_Dist.dat
HOT SOAK ACTIVITY  : Mex_Hot_Soak_WeekDay.dat
DIURN SOAK ACTIVITY: Mex_Diurn_Soak_WeekDay.dat
PARTICULATE EF     : PMGZML.CSV PMGDR1.CSV PMGDR2.CSV PMDZML.CSV PMDDR1.CSV PMDDR2.CSV
PARTICLE SIZE      : 10.0
DIESEL SULFUR      : 300.0
AVERAGE SPEED      : 65.0 arterial

*********************** End of Run *********************
END OF
```

Appendix 6

Example emission rates obtained with MOBILE6-Mexico (condition A, period 1)

Carbon monoxide

[grams / Vehicle Miles of Travel]

a1	CO																											
speed	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV2b	HDGV3	HDGV4	HDGV5	HDGV6	HDGV7	HDGV8a	HDGV8b	LDDV	LDDT12	HDDV2b	HDDV3	HDDV4	HDDV5	HDDV6	HDDV7	HDDV8a	HDDV8b	MC	HDGB	HDDBT	HDDBS	LDDT34
3	198.877	145.322	156.136	268.842	268.855	370.639	805.501	865.243	582.730	686.057	1094.771	1111.882	0.000	9.296	16.823	17.427	25.263	26.354	24.624	38.720	47.650	81.739	110.816	91.636	1307.904	96.013	38.355	6.877
4	158.516	116.008	124.616	215.786	215.798	337.371	733.202	787.582	530.426	624.479	996.508	1012.083	0.000	8.761	16.026	16.006	23.204	24.206	22.616	35.564	43.766	75.076	101.782	76.320	1190.511	88.186	35.229	6.418
5	134.300	98.420	105.704	183.953	183.963	317.411	689.822	740.985	499.044	587.532	937.550	952.203	0.000	8.441	15.547	15.154	21.968	22.917	21.412	33.670	41.435	71.078	96.362	67.131	1120.075	83.490	33.353	6.142
6	120.062	88.504	95.041	165.920	165.929	282.000	612.864	658.318	443.369	521.985	832.954	845.973	0.000	7.850	14.667	13.585	19.695	20.545	19.196	30.185	37.147	63.722	86.390	58.522	995.116	74.850	29.901	5.635
7	109.892	81.421	87.424	153.038	153.047	256.706	557.894	599.271	403.601	475.166	758.243	770.094	0.000	7.429	14.038	12.465	18.071	18.851	17.613	27.696	34.084	58.467	79.266	52.372	905.860	68.678	27.435	5.272
8	102.264	76.109	81.711	143.378	143.386	237.736	516.666	554.985	373.775	440.052	702.210	713.185	0.000	7.113	13.566	11.625	16.853	17.580	16.426	25.830	31.787	54.527	73.924	47.761	838.918	64.049	25.586	5.001
9	96.332	71.977	77.268	135.864	135.872	222.981	484.600	520.541	350.578	412.741	658.628	668.922	0.000	6.867	13.200	10.972	15.905	16.592	15.503	24.378	30.000	51.462	69.769	44.173	786.852	60.449	24.148	4.789
10	91.586	68.672	73.713	129.853	129.860	211.177	458.947	492.986	332.019	390.892	623.763	633.512	0.000	6.670	12.906	10.449	15.148	15.802	14.764	23.216	28.571	49.010	66.444	41.304	745.199	57.569	22.997	4.620
11	88.566	66.721	71.617	126.368	126.375	194.068	421.763	453.044	305.119	359.222	573.226	582.185	0.000	6.372	12.461	9.656	13.998	14.602	13.643	21.454	26.401	45.289	61.400	39.098	684.823	53.198	21.252	4.364
12	86.050	65.096	69.870	123.464	123.471	179.810	390.777	419.760	282.703	332.830	531.112	539.413	0.000	6.123	12.090	8.995	13.039	13.602	12.709	19.985	24.594	42.188	57.196	37.259	634.510	49.556	19.797	4.150
13	83.921	63.720	68.393	121.006	121.013	167.745	364.558	391.596	263.735	310.499	495.477	503.221	0.000	5.912	11.776	8.435	12.228	12.756	11.919	18.742	23.064	39.565	53.639	35.703	591.937	46.474	18.565	3.969
14	82.096	62.541	67.126	118.900	118.907	157.405	342.084	367.455	247.476	291.358	464.932	472.199	0.000	5.732	11.507	7.956	11.533	12.031	11.241	17.677	21.753	37.316	50.590	34.370	555.447	43.832	17.510	3.814
15	80.515	61.519	66.028	117.075	117.081	148.442	322.607	346.534	233.386	274.769	438.461	445.314	0.000	5.576	11.273	7.540	10.931	11.403	10.654	16.753	20.617	35.367	47.948	33.214	523.821	41.543	16.596	3.680
16	79.131	60.625	65.067	115.477	115.484	138.893	301.853	324.241	218.372	257.093	410.254	416.666	0.000	5.402	11.014	7.079	10.262	10.705	10.002	15.728	19.356	33.202	45.014	32.231	490.123	39.001	15.580	3.530
17	77.910	59.837	64.220	114.068	114.075	130.467	283.541	304.570	205.124	241.496	385.365	391.388	0.000	5.249	10.786	6.672	9.672	10.089	9.427	14.824	18.242	31.293	42.425	31.364	460.389	36.758	14.684	3.399
18	76.824	59.135	63.466	112.815	112.822	122.977	267.263	287.085	193.348	227.632	363.242	368.919	0.000	5.113	10.583	6.310	9.147	9.542	8.916	14.019	17.253	29.595	40.123	30.594	433.959	34.764	13.887	3.282
19	75.853	58.508	62.792	111.694	111.701	116.275	252.699	271.441	182.812	215.228	343.448	348.816	0.000	4.991	10.401	5.986	8.678	9.052	8.458	13.300	16.367	28.076	38.064	29.904	410.311	32.980	13.175	3.177
20	74.979	57.943	62.185	110.686	110.692	110.244	239.591	257.361	173.329	204.063	325.633	330.722	0.000	4.881	10.237	5.694	8.255	8.612	8.046	12.652	15.570	26.710	36.211	29.284	389.028	31.374	12.533	3.083
21	74.214	57.472	61.675	109.815	109.821	104.592	227.307	244.166	164.443	193.601	308.937	313.766	0.000	4.774	10.078	5.410	7.843	8.182	7.645	12.021	14.793	25.376	34.404	28.541	369.082	29.808	11.908	2.991
22	73.518	57.043	61.212	109.023	109.030	99.453	216.140	232.171	156.364	184.090	293.760	298.351	0.000	4.677	9.933	5.152	7.469	7.791	7.280	11.447	14.087	24.165	32.761	27.865	350.950	28.384	11.339	2.907
23	72.883	56.652	60.788	108.301	108.307	94.762	205.944	221.218	148.988	175.405	279.902	284.277	0.000	4.588	9.800	4.916	7.127	7.434	6.946	10.923	13.442	23.058	31.261	27.249	334.394	27.085	10.820	2.831
24	72.300	56.293	60.400	107.638	107.644	90.461	196.597	211.178	142.226	167.445	267.199	271.375	0.000	4.507	9.679	4.700	6.813	7.107	6.641	10.442	12.850	22.044	29.885	26.683	319.218	25.893	10.344	2.761
25	71.764	55.963	60.043	107.028	107.035	86.505	187.999	201.942	136.005	160.121	255.512	259.506	0.000	4.432	9.567	4.501	6.525	6.806	6.360	10.000	12.306	21.111	28.620	26.163	305.256	24.797	9.906	2.697
26	71.317	55.719	59.774	106.529	106.535	83.092	180.581	193.974	130.639	153.804	245.431	249.267	0.000	4.364	9.466	4.321	6.264	6.535	6.106	9.601	11.816	20.269	27.479	25.494	293.212	23.808	9.511	2.639
27	70.902	55.493	59.525	106.067	106.073	79.931	173.713	186.597	125.671	147.954	236.097	239.787	0.000	4.302	9.373	4.155	6.024	6.284	5.871	9.232	11.361	19.489	26.422	24.875	282.061	22.892	9.145	2.585
28	70.517	55.283	59.294	105.637	105.644	76.997	167.336	179.747	121.057	142.522	227.429	230.983	0.000	4.244	9.286	4.001	5.800	6.050	5.653	8.889	10.939	18.765	25.440	24.299	271.705	22.042	8.805	2.535
29	70.159	55.088	59.078	105.238	105.244	74.265	161.398	173.369	116.761	137.465	219.359	222.787	0.000	4.190	9.206	3.857	5.591	5.833	5.450	8.570	10.546	18.091	24.527	23.764	262.064	21.250	8.489	2.488
30	69.825	54.906	58.877	104.865	104.871	71.715	155.856	167.416	112.752	132.745	211.827	215.138	0.000	4.139	9.130	3.723	5.397	5.630	5.260	8.272	10.180	17.462	23.674	23.264	253.066	20.511	8.194	2.445
31	69.630	54.873	58.827	104.682	104.688	69.705	151.489	162.724	109.593	129.025	205.891	209.109	0.000	4.097	9.067	3.610	5.233	5.459	5.101	8.021	9.871	16.932	22.956	22.729	245.975	19.889	7.945	2.408
32	69.448	54.841	58.781	104.510	104.516	67.821	147.394	158.326	106.631	125.538	200.326	203.457	0.000	4.057	9.008	3.504	5.080	5.299	4.951	7.786	9.581	16.436	22.282	22.228	239.327	19.306	7.712	2.374
33	69.277	54.812	58.737	104.349	104.355	66.051	143.548	154.195	103.848	122.262	195.099	198.148	0.000	4.019	8.952	3.405	4.936	5.149	4.811	7.565	9.309	15.969	21.650	21.757	233.081	18.758	7.493	2.342
34	69.116	54.784	58.696	104.197	104.203	64.386	139.928	150.306	101.229	119.179	190.179	193.151	0.000	3.984	8.899	3.311	4.800	5.007	4.678	7.357	9.053	15.530	21.055	21.314	227.203	18.242	7.287	2.312
35	68.965	54.758	58.657	104.054	104.061	62.815	136.515	146.640	98.760	116.272	185.540	188.440	0.000	3.951	8.850	3.223	4.672	4.874	4.554	7.161	8.812	15.116	20.494	20.896	221.661	17.756	7.093	2.283
36	69.141	55.009	58.906	104.312	104.319	61.774	134.253	144.210	97.123	114.345	182.465	185.317	0.000	3.926	8.812	3.155	4.574	4.772	4.459	7.011	8.628	14.800	20.065	20.565	217.988	17.385	6.945	2.261
37	69.309	55.247	59.141	104.557	104.563	60.790	132.113	141.911	95.575	112.522	179.557	182.363	0.000	3.902	8.776	3.092	4.482	4.676	4.369	6.869	8.454	14.502	19.660	20.251	214.513	17.034	6.805	2.241
38	69.467	55.472	59.364	104.788	104.794	59.857	130.085	139.733	94.109	110.796	176.801	179.565	0.000	3.879	8.742	3.031	4.395	4.584	4.283	6.735	8.289	14.219	19.277	19.954	211.221	16.702	6.672	2.221
39	69.617	55.685	59.576	105.007	105.014	58.972	128.162	137.667	92.717	109.157	174.187	176.910	0.000	3.857	8.710	2.974	4.312	4.498	4.202	6.608	8.132	13.950	18.912	19.673	208.098	16.386	6.546	2.203
40	69.760	55.888	59.777	105.216	105.223	58.131	126.335	135.705	91.395	107.601	171.704	174.387	0.000	3.837	8.680	2.920	4.233	4.415	4.126	6.487	7.984	13.695	18.567	19.405	205.131	16.086	6.426	2.185
41	69.934	56.136	60.023	105.471	105.478	57.847	125.718	135.042	90.949	107.076	170.865	173.536	0.000	3.824	8.661	2.887	4.185	4.365	4.079	6.413	7.893	13.539	18.355	19.282	204.130	15.903	6.353	2.175
42	70.101	56.372	60.257	105.714	105.721	57.577	125.130	134.411	90.524	106.575	170.066	172.725	0.000	3.813	8.643	2.855	4.139	4.317	4.034	6.343	7.806	13.391	18.154	19.164	203.175	15.729	6.283	2.164
43	70.259	56.597	60.480	105.945	105.952	57.319	124.570	133.809	90.118	106.098	169.305	171.951	0.000	3.801	8.626	2.825	4.095	4.272	3.991	6.276	7.724	13.249	17.962	19.052	202.266	15.563	6.217	2.155
44	70.410	56.812	60.693	106.166	106.173	57.073	124.035	133.234	89.732	105.642	168.578	171.213	0.000	3.790	8.610	2.796	4.053	4.228	3.951	6.212	7.645	13.114	17.779	18.945	201.397	15.404	6.154	2.145
45	70.555	57.018	60.897	106.378	106.385	56.838	123.524	132.685	89.362	105.207	167.884	170.507	0.000	3.780	8.595	2.768	4.013	4.186	3.912	6.151	7.570	12.985	17.604	18.843	200.568	15.252	6.093	2.136
46	70.728	57.263	61.141	106.630	106.637	57.246	124.411	133.638	90.004	105.963	169.089	171.732	0.000	3.778	8.592	2.764	4.006	4.179	3.905	6.141	7.557	12.963	17.574	18.835	202.008	15.227	6.083	2.135
47	70.893	57.498	61.374	106.872	106.879	57.637	125.260	134.550	90.618	106.686	170.243	172.904	0.000	3.777	8.589	2.759	4.000	4.173	3.899	6.131	7.545	12.942	17.546	18.828	203.387	15.202	6.073	2.133
48	71.052	57.724	61.597	107.104	107.111	58.011	126.074	135.425	91.207	107.379	171.350	174.028	0.000	3.775	8.587	2.755	3.994	4.166	3.893	6.121	7.533	12.922	17.519	18.820	204.708	15.179	6.064	2.132
49	71.204	57.940	61.811	107.326	107.333	58.370	126.855	136.263	91.772	108.044	172.411	175.105	0.000	3.773	8.585	2.751	3.988	4.160	3.887	6.112	7.522	12.903	17.493	18.813	205.976	15.156	6.055	2.131
50	71.350	58.147	62.017	107.539	107.547	58.715	127.604	137.068	92.314	108.683	173.429	176.140	0.000	3.772	8.583	2.747	3.982	4.154	3.881	6.103	7.511	12.884	17.468	18.807	207.193	15.135	6.046	2.129
51	71.522	58.391	62.259	107.790	107.797	59.873	130.121	139.772	94.134	110.826	176.850	179.614	0.000	3.781	8.595	2.770	4.015	4.189	3.914	6.154	7.573	12.991	17.613	18.807	211.279	15.260	6.096	2.137
52	71.687	58.625	62.491	108.031	108.038	60.987	132.541	142.371	95.885	112.887	180.139	182.954	0.000	3.789	8.608	2.792	4.047	4.222	3.945	6.203	7.633	13.094	17.752	18.807	215.209	15.381	6.144	2.144
53	71.845	58.851	62.715	108.263	108.270	62.058	134.870	144.873	97.570	114.870	183.304	186.169	0.000	3.797	8.620	2.813	4.078	4.254	3.974	6.250	7.691	13.193	17.886	18.807	218.990	15.497	6.191	2.151
54	71.998	59.068	62.930	108.486	108.494	63.090	137.112	147.281	99.192	116.780	186.351	189.264	0.000	3.804	8.631	2.833	4.107	4.284	4.003	6.295	7.747	13.288	18.015	18.807	222.631	15.609	6.235	2.157
55	72.145	59.277	63.137	108.701	108.709	64.084	139.273	149.602	100.755	118.621	189.288	192.247	0.000	3.812	8.642	2.853	4.135	4.314	4.031	6.338	7.800	13.380	18.140	18.807	226.139	15.717	6.279	2.164
56	72.316	59.519	63.377	108.950	108.958	66.187	143.844	154.512	104.062	122.514	195.500	198.556	0.000	3.832	8.672	2.906	4.212	4.394	4.106	6.456	7.945	13.629	18.477	22.167	233.561	16.009	6.395	2.181
57	72.480	59.753	63.609	109.190	109.198	68.217	148.254	159.249	107.252	126.270	201.494	204.644	0.000	3.851	8.700	2.957	4.287	4.472	4.178	6.570	8.085	13.869	18.803	25.409	240.722	16.291	6.508	2.197
58	72.639	59.978	63.832	109.422	109.430	70.176	152.512	163.824	110.333	129.897	207.282	210.522	0.000	3.870	8.728	3.006	4.358	4.546	4.248	6.680	8.220	14.101	19.117	28.539	247.636	16.564	6.617	2.213
59	72.792	60.196	64.048	109.646	109.654	72.069	156.626	168.243	113.309	133.401	212.873	216.200	0.000	3.888	8.755	3.054	4.428	4.619	4.315	6.786	8.351	14.325	19.421	31.563	254.316	16.827	6.722	2.229
60	72.941	60.407	64.257	109.863	109.871	73.899	160.603	172.514	116.186	136.788	218.278	221.690	0.000	3.905	8.781	3.100	4.494	4.688	4.381	6.888	8.477	14.542	19.715	34.487	260.773	17.081	6.824	2.244
61	73.110	60.647	64.496	110.110	110.118	77.338	168.076	180.542	121.593	143.153	228.436	232.006	0.000	3.939	8.832	3.191	4.626	4.826	4.509	7.090	8.725	14.968	20.292	37.829	272.908	17.581	7.023	2.273
62	73.274	60.880	64.727	110.350	110.358	80.666	175.309	188.311	126.825	149.313	238.265	241.989	0.000	3.972	8.881	3.279	4.753	4.959	4.633	7.285	8.966	15.380	20.851	41.062	284.652	18.065	7.217	2.301
63	73.433	61.106	64.951	110.582	110.590	83.888	182.312	195.833	131.891	155.278	247.783	251.656	0.000	4.004	8.929	3.364	4.877	5.087	4.753	7.474	9.198	15.779	21.392	44.194	296.022	18.534	7.404	2.329
64	73.587	61.324	65.167	110.807	110.815	87.009	189.096	203.120	136.799	161.056	257.003	261.020	0.000	4.035	8.975	3.446	4.996	5.212	4.870	7.658	9.424	16.165	21.916	47.227	307.037	18.988	7.585	2.356
65	73.736	61.536	65.377	111.024	111.033	90.035	195.671	210.183	141.556	166.656	265.940	270.096	0.000	4.065	9.020	3.526	5.112	5.333	4.983	7.835	9.642	16.540	22.424	50.167	317.714	19.428	7.761	2.381

Nitrogen oxides

[grams / Vehicle Miles of Travel]

a1	NOx																											
speed	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV2b	HDGV3	HDGV4	HDGV5	HDGV6	HDGV7	HDGV8a	HDGV8b	LDDV	LDDT12	HDDV2b	HDDV3	HDDV4	HDDV5	HDDV6	HDDV7	HDDV8a	HDDV8b	MC	HDGB	HDDBT	HDDBS	LDDT34
3	3.214	3.181	3.212	3.679	3.687	3.425	4.306	4.558	4.536	4.735	5.822	6.246	0.000	3.052	4.530	9.422	12.680	13.847	14.234	21.030	25.566	38.181	45.429	0.889	4.557	38.468	23.488	2.471
4	3.103	3.050	3.076	3.526	3.533	3.462	4.353	4.607	4.585	4.786	5.884	6.313	0.000	2.927	4.351	9.011	12.126	13.243	13.613	20.118	24.457	36.728	43.734	0.850	4.605	36.790	22.463	2.367
5	3.036	2.971	2.994	3.433	3.441	3.484	4.380	4.637	4.614	4.817	5.922	6.353	0.000	2.851	4.244	8.764	11.794	12.880	13.240	19.571	23.791	35.855	42.717	0.827	4.635	35.783	21.848	2.304
6	2.907	2.834	2.851	3.272	3.279	3.543	4.454	4.715	4.692	4.898	6.022	6.461	0.000	2.699	4.027	8.267	11.125	12.149	12.488	18.467	22.449	34.095	40.665	0.800	4.713	33.751	20.607	2.177
7	2.815	2.735	2.748	3.157	3.164	3.585	4.507	4.771	4.748	4.956	6.094	6.538	0.000	2.591	3.872	7.911	10.646	11.627	11.951	17.679	21.490	32.838	39.199	0.781	4.769	32.300	19.721	2.087
8	2.746	2.662	2.671	3.071	3.078	3.617	4.547	4.813	4.790	5.000	6.147	6.595	0.000	2.509	3.756	7.644	10.287	11.235	11.549	17.087	20.771	31.896	38.100	0.767	4.811	31.211	19.057	2.019
9	2.692	2.604	2.612	3.004	3.010	3.641	4.578	4.846	4.822	5.034	6.189	6.640	0.000	2.446	3.666	7.437	10.008	10.930	11.235	16.628	20.211	31.162	37.245	0.755	4.844	30.364	18.540	1.966
10	2.649	2.559	2.564	2.951	2.957	3.661	4.602	4.872	4.848	5.061	6.222	6.676	0.000	2.395	3.594	7.271	9.785	10.686	10.985	16.260	19.764	30.576	36.561	0.746	4.870	29.687	18.126	1.924
11	2.581	2.488	2.490	2.870	2.876	3.709	4.663	4.936	4.912	5.128	6.304	6.763	0.000	2.310	3.473	6.993	9.411	10.277	10.564	15.642	19.013	29.591	35.414	0.750	4.934	28.551	17.432	1.853
12	2.525	2.429	2.428	2.803	2.809	3.749	4.713	4.989	4.965	5.183	6.372	6.837	0.000	2.239	3.372	6.761	9.098	9.936	10.214	15.128	18.387	28.771	34.458	0.753	4.987	27.604	16.854	1.794
13	2.478	2.378	2.376	2.746	2.752	3.783	4.756	5.034	5.010	5.230	6.430	6.899	0.000	2.179	3.286	6.565	8.834	9.648	9.917	14.692	17.858	28.077	33.648	0.756	5.032	26.802	16.365	1.744
14	2.437	2.336	2.331	2.697	2.703	3.812	4.793	5.073	5.049	5.270	6.479	6.952	0.000	2.128	3.213	6.396	8.608	9.400	9.663	14.319	17.404	27.482	32.955	0.758	5.071	26.115	15.945	1.702
15	2.402	2.298	2.293	2.655	2.661	3.837	4.824	5.107	5.082	5.305	6.522	6.998	0.000	2.083	3.150	6.251	8.412	9.186	9.443	13.996	17.011	26.967	32.354	0.760	5.105	25.520	15.582	1.665
16	2.371	2.266	2.259	2.618	2.624	3.882	4.880	5.166	5.140	5.366	6.597	7.078	0.000	2.031	3.075	6.080	8.182	8.935	9.185	13.617	16.550	26.363	31.650	0.777	5.163	24.823	15.156	1.621
17	2.343	2.237	2.229	2.586	2.591	3.921	4.929	5.217	5.192	5.420	6.664	7.149	0.000	1.985	3.010	5.929	7.979	8.714	8.957	13.282	16.143	25.830	31.028	0.791	5.215	24.207	14.780	1.583
18	2.319	2.212	2.202	2.557	2.562	3.955	4.972	5.263	5.238	5.468	6.723	7.212	0.000	1.944	2.951	5.795	7.799	8.517	8.755	12.985	15.782	25.356	30.476	0.804	5.261	23.660	14.446	1.549
19	2.297	2.189	2.178	2.531	2.536	3.986	5.011	5.305	5.279	5.511	6.775	7.269	0.000	1.907	2.899	5.675	7.637	8.341	8.574	12.719	15.459	24.932	29.982	0.816	5.303	23.171	14.148	1.518
20	2.278	2.168	2.157	2.508	2.512	4.014	5.046	5.342	5.316	5.549	6.823	7.320	0.000	1.874	2.852	5.567	7.492	8.182	8.411	12.480	15.168	24.551	29.537	0.826	5.340	22.731	13.879	1.491
21	2.260	2.150	2.137	2.487	2.491	4.056	5.099	5.398	5.372	5.607	6.894	7.396	0.000	1.843	2.808	5.465	7.355	8.032	8.256	12.253	14.892	24.189	29.116	0.847	5.396	22.313	13.624	1.465
22	2.244	2.133	2.120	2.467	2.472	4.094	5.147	5.449	5.422	5.660	6.959	7.466	0.000	1.814	2.767	5.372	7.230	7.895	8.116	12.047	14.641	23.861	28.732	0.865	5.446	21.934	13.392	1.441
23	2.229	2.118	2.104	2.450	2.455	4.129	5.191	5.495	5.468	5.709	7.018	7.530	0.000	1.789	2.730	5.287	7.115	7.771	7.988	11.859	14.412	23.561	28.383	0.882	5.493	21.587	13.181	1.420
24	2.216	2.103	2.089	2.434	2.438	4.161	5.231	5.538	5.511	5.753	7.073	7.588	0.000	1.765	2.696	5.210	7.011	7.656	7.870	11.687	14.203	23.286	28.062	0.897	5.535	21.270	12.987	1.400
25	2.204	2.090	2.075	2.419	2.424	4.191	5.268	5.577	5.550	5.794	7.123	7.642	0.000	1.743	2.665	5.138	6.914	7.551	7.762	11.528	14.010	23.032	27.767	0.912	5.575	20.978	12.808	1.382
26	2.192	2.078	2.063	2.405	2.410	4.231	5.320	5.631	5.604	5.850	7.192	7.716	0.000	1.727	2.643	5.086	6.845	7.475	7.684	11.413	13.870	22.849	27.553	0.931	5.629	20.766	12.679	1.368
27	2.182	2.067	2.051	2.393	2.397	4.269	5.367	5.681	5.654	5.902	7.256	7.785	0.000	1.712	2.622	5.038	6.780	7.404	7.611	11.306	13.740	22.679	27.355	0.948	5.679	20.570	12.559	1.356
28	2.172	2.057	2.041	2.381	2.386	4.304	5.411	5.728	5.700	5.950	7.316	7.849	0.000	1.699	2.602	4.994	6.720	7.339	7.544	11.207	13.620	22.521	27.171	0.964	5.726	20.388	12.448	1.345
29	2.163	2.047	2.030	2.370	2.375	4.337	5.452	5.771	5.743	5.996	7.371	7.908	0.000	1.686	2.584	4.952	6.664	7.278	7.481	11.115	13.508	22.374	27.000	0.979	5.769	20.218	12.345	1.334
30	2.154	2.038	2.021	2.360	2.364	4.367	5.490	5.812	5.784	6.038	7.423	7.964	0.000	1.674	2.567	4.913	6.612	7.221	7.422	11.029	13.403	22.237	26.840	0.993	5.810	20.060	12.248	1.324
31	2.150	2.035	2.017	2.355	2.360	4.407	5.541	5.865	5.836	6.093	7.491	8.037	0.000	1.671	2.563	4.903	6.598	7.206	7.407	11.006	13.375	22.201	26.798	1.008	5.863	20.018	12.222	1.322
32	2.146	2.031	2.013	2.351	2.356	4.445	5.588	5.915	5.886	6.145	7.554	8.105	0.000	1.668	2.559	4.893	6.585	7.192	7.392	10.985	13.350	22.167	26.758	1.022	5.912	19.979	12.199	1.319
33	2.142	2.028	2.010	2.347	2.352	4.480	5.632	5.961	5.932	6.193	7.614	8.169	0.000	1.665	2.555	4.884	6.573	7.178	7.379	10.965	13.325	22.136	26.721	1.035	5.959	19.942	12.176	1.317
34	2.138	2.025	2.007	2.343	2.348	4.513	5.673	6.005	5.976	6.239	7.670	8.229	0.000	1.663	2.551	4.876	6.562	7.166	7.366	10.946	13.302	22.106	26.686	1.047	6.003	19.908	12.155	1.315
35	2.134	2.022	2.003	2.340	2.344	4.544	5.713	6.047	6.018	6.282	7.723	8.286	0.000	1.660	2.548	4.868	6.551	7.154	7.354	10.929	13.281	22.077	26.654	1.059	6.045	19.875	12.135	1.313
36	2.138	2.026	2.008	2.344	2.348	4.583	5.762	6.099	6.070	6.336	7.790	8.357	0.000	1.669	2.560	4.897	6.590	7.197	7.397	10.992	13.359	22.179	26.772	1.069	6.097	19.993	12.207	1.320
37	2.142	2.030	2.012	2.347	2.352	4.620	5.809	6.149	6.119	6.387	7.853	8.425	0.000	1.677	2.572	4.924	6.626	7.236	7.439	11.053	13.432	22.275	26.884	1.079	6.146	20.104	12.275	1.327
38	2.146	2.034	2.016	2.351	2.355	4.655	5.853	6.195	6.165	6.436	7.913	8.489	0.000	1.685	2.583	4.950	6.661	7.274	7.478	11.110	13.501	22.367	26.991	1.088	6.193	20.209	12.339	1.334
39	2.149	2.037	2.020	2.354	2.359	4.689	5.895	6.240	6.209	6.482	7.969	8.550	0.000	1.693	2.594	4.974	6.694	7.310	7.515	11.164	13.567	22.453	27.091	1.097	6.237	20.309	12.400	1.340
40	2.152	2.040	2.023	2.358	2.362	4.721	5.935	6.282	6.251	6.526	8.023	8.608	0.000	1.700	2.604	4.997	6.725	7.344	7.550	11.216	13.630	22.535	27.187	1.105	6.279	20.404	12.458	1.346
41	2.158	2.046	2.029	2.363	2.368	4.759	5.983	6.334	6.303	6.580	8.089	8.679	0.000	1.721	2.635	5.067	6.819	7.447	7.655	11.371	13.819	22.782	27.475	1.112	6.331	20.689	12.632	1.364
42	2.163	2.052	2.035	2.369	2.373	4.796	6.030	6.383	6.352	6.631	8.152	8.746	0.000	1.742	2.663	5.134	6.909	7.545	7.756	11.518	13.998	23.018	27.750	1.119	6.380	20.961	12.798	1.381
43	2.168	2.057	2.041	2.374	2.378	4.831	6.074	6.430	6.398	6.679	8.212	8.810	0.000	1.761	2.691	5.197	6.994	7.638	7.852	11.659	14.169	23.242	28.011	1.126	6.427	21.220	12.956	1.397
44	2.172	2.063	2.046	2.379	2.383	4.865	6.116	6.474	6.443	6.726	8.269	8.871	0.000	1.779	2.717	5.258	7.076	7.727	7.943	11.794	14.333	23.456	28.261	1.133	6.472	21.467	13.107	1.412
45	2.177	2.067	2.051	2.383	2.388	4.897	6.157	6.517	6.485	6.770	8.324	8.930	0.000	1.797	2.743	5.316	7.154	7.812	8.031	11.922	14.489	23.661	28.500	1.139	6.514	21.703	13.251	1.427
46	2.182	2.073	2.058	2.389	2.394	4.936	6.205	6.568	6.536	6.823	8.389	9.000	0.000	1.833	2.794	5.434	7.312	7.986	8.209	12.184	14.807	24.078	28.986	1.150	6.566	22.185	13.546	1.457
47	2.187	2.079	2.064	2.394	2.399	4.972	6.251	6.617	6.585	6.874	8.451	9.067	0.000	1.868	2.843	5.547	7.465	8.152	8.380	12.434	15.112	24.478	29.452	1.161	6.614	22.647	13.827	1.486
48	2.192	2.084	2.069	2.400	2.404	5.008	6.295	6.664	6.632	6.923	8.511	9.131	0.000	1.901	2.890	5.655	7.610	8.311	8.543	12.675	15.404	24.861	29.899	1.171	6.661	23.089	14.097	1.513
49	2.196	2.089	2.075	2.405	2.409	5.041	6.338	6.709	6.676	6.970	8.569	9.193	0.000	1.933	2.936	5.759	7.750	8.464	8.700	12.905	15.684	25.228	30.327	1.181	6.706	23.513	14.356	1.539
50	2.201	2.094	2.080	2.409	2.414	5.074	6.379	6.752	6.719	7.014	8.624	9.252	0.000	1.963	2.979	5.859	7.884	8.610	8.851	13.126	15.953	25.581	30.738	1.191	6.749	23.920	14.605	1.565
51	2.207	2.100	2.086	2.415	2.420	5.112	6.427	6.803	6.770	7.067	8.688	9.322	0.000	2.018	3.057	6.038	8.126	8.874	9.122	13.524	16.437	26.215	31.478	1.207	6.800	24.652	15.052	1.610
52	2.212	2.106	2.092	2.421	2.426	5.149	6.473	6.851	6.818	7.118	8.751	9.388	0.000	2.071	3.132	6.211	8.358	9.127	9.382	13.907	16.903	26.825	32.189	1.223	6.849	25.357	15.482	1.654
53	2.217	2.112	2.098	2.427	2.431	5.184	6.517	6.898	6.865	7.166	8.811	9.453	0.000	2.121	3.204	6.377	8.581	9.371	9.633	14.275	17.350	27.412	32.873	1.239	6.896	26.034	15.896	1.697
54	2.222	2.117	2.104	2.432	2.437	5.218	6.560	6.944	6.910	7.213	8.868	9.514	0.000	2.170	3.274	6.536	8.796	9.606	9.875	14.630	17.782	27.977	33.532	1.254	6.941	26.687	16.294	1.737
55	2.227	2.122	2.109	2.437	2.442	5.250	6.601	6.987	6.953	7.259	8.924	9.574	0.000	2.217	3.341	6.690	9.004	9.833	10.107	14.971	18.197	28.522	34.167	1.268	6.984	27.316	16.678	1.776
56	2.233	2.129	2.116	2.444	2.448	5.288	6.648	7.037	7.003	7.311	8.988	9.643	0.000	2.298	3.455	6.953	9.357	10.219	10.504	15.554	18.906	29.451	35.250	1.285	7.035	28.388	17.333	1.843
57	2.239	2.134	2.122	2.450	2.455	5.325	6.694	7.086	7.052	7.361	9.050	9.710	0.000	2.375	3.566	7.207	9.698	10.591	10.887	16.116	19.590	30.347	36.295	1.301	7.083	29.423	17.965	1.908
58	2.244	2.140	2.128	2.456	2.460	5.360	6.738	7.133	7.098	7.410	9.110	9.774	0.000	2.450	3.672	7.451	10.027	10.951	11.257	16.659	20.250	31.213	37.304	1.316	7.130	30.422	18.575	1.970
59	2.249	2.146	2.133	2.461	2.466	5.394	6.781	7.178	7.143	7.457	9.168	9.836	0.000	2.522	3.775	7.688	10.346	11.298	11.614	17.184	20.888	32.049	38.279	1.331	7.175	31.388	19.164	2.030
60	2.255	2.151	2.139	2.467	2.472	5.427	6.823	7.222	7.187	7.503	9.224	9.896	0.000	2.592	3.875	7.916	10.653	11.634	11.959	17.690	21.504	32.857	39.221	1.346	7.219	32.321	19.734	2.088
61	2.260	2.157	2.145	2.473	2.478	5.465	6.870	7.272	7.237	7.555	9.288	9.965	0.000	2.709	4.041	8.298	11.166	12.195	12.535	18.536	22.533	34.205	40.793	1.362	7.269	33.878	20.685	2.185
62	2.266	2.163	2.152	2.479	2.484	5.501	6.916	7.321	7.285	7.605	9.350	10.031	0.000	2.822	4.201	8.667	11.663	12.737	13.093	19.355	23.528	35.510	42.314	1.378	7.318	35.384	21.604	2.279
63	2.272	2.169	2.158	2.485	2.490	5.536	6.960	7.368	7.332	7.654	9.410	10.096	0.000	2.931	4.357	9.024	12.144	13.262	13.632	20.147	24.492	36.773	43.787	1.394	7.365	36.843	22.495	2.370
64	2.277	2.174	2.163	2.491	2.496	5.571	7.003	7.413	7.377	7.701	9.468	10.158	0.000	3.037	4.507	9.370	12.609	13.770	14.155	20.915	25.425	37.997	45.214	1.409	7.410	38.256	23.358	2.458
65	2.282	2.179	2.169	2.497	2.501	5.604	7.045	7.457	7.421	7.747	9.524	10.218	0.000	3.139	4.653	9.705	13.061	14.263	14.662	21.659	26.330	39.183	46.597	1.423	7.454	39.625	24.194	2.543

APPENDIX B

ADDITIONAL POINT SOURCE DATA

Baja California: 1999 Point Source Emissions Inventory (Final)
Mg/year, by NAICS

3Digit NAICS		Number of Facilities	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
212 Total	Mining (except oil & gas)	1	9.3	31.3	0.1	2.3	448.1	130.9
221 Total	Utilities	4	4,294.5	24,195.9	68.0	448.0	1,633.3	1,604.7
311 Total	Food Manufacturing	8	368.7	766.7	24.5	56.8	63.0	39.4
312 Total	Beverage & Tobacco Product Manufacturing	1	10.9		0.2	1.9	3.3	
315 Total	Apparel Manufacturing	2			294.2			
321 Total	Wood Product Manufacturing	11	0.8		496.1	0.1		
322 Total	Paper Manufacturing	4	5.3	49.7	282.3	0.5	2.4	2.1
324 Total	Petroleum & Coal Products Manufacturing	1	2.8	30.1	4.3	0.3	3.9	3.4
325 Total	Chemical Manufacturing	12	13.2	73.7	521.1	12.8	501.7	483.4
326 Total	Plastics & Rubber Manufacturing	4	44.3	375.5	80.2	2.8	17.6	15.3
327 Total	Nonmetallic Mineral Products Manufacturing	8	809.6	1,028.4	1,110.9	11.4	826.3	730.2
331 Total	Primary Metal Manufacturing	4	35.1	0.0	181.3	6.1	10.9	0.5
332 Total	Fabricated Metal Product Manufacturing	13	36.7	40.7	1,711.1	45.1	1,127.2	787.5
333 Total	Machinery Manufacturing	6	4.1		149.4	0.7	0.1	0.1
334 Total	Computer & Electronic Product Manufacturing	24	18.2	2.7	1,805.7	3.7	0.4	0.4
335 Total	Electrical Equipment, Appliance & Component Manufacturing	5	4.1	1.2	244.6	139.9	25.7	19.5
336 Total	Transportation Equipment Manufacturing	7	17.4	9.3	7,300.1	21.6	9.2	8.9
337 Total	Furniture & Related Product Manufacturing	12	1.0		878.4	0.2		
339 Total	Miscellaneous Manufacturing	27	19.4	0.1	776.1	3.7	24.2	23.3
424 Total	Merchant Wholesalers, Nondurable Goods	2			638.5			
Total		**156**	**5,695.4**	**26,605.1**	**16,567.3**	**757.8**	**4,697.4**	**3,849.7**

Coahuila: 1999 Point Source Emissions Inventory (Final)
Mg/year, by NAICS

3Digit NAICS		Number of Facilities	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
212 Total	Mining (except oil & gas)	9	575.9	1,515.5	21.4	7,997.2	362.3	165.9
221 Total	Utilities	5	103,681.9	150,701.5	174.4	2,187.7	8,154.0	8,011.1
322 Total	Paper Manufacturing	1	47.9	0.3	4.2	40.2	46.7	35.5
325 Total	Chemical Manufacturing	9	2,184.6	395.6	17.0	549.1	232.7	123.3
327 Total	Nonmetallic Mineral Products Manufacturing	3	1,313.2	87.7	127.1	5,042.1	140.7	97.6
331 Total	Primary Metal Manufacturing	6	5,156.0	4,949.1	0.3	55.8	7,428.2	7,229.0
332 Total	Fabricated Metal Product Manufacturing	4	43.7	0.1	0.1	6.6	3,243.8	3,169.5
333 Total	Machinery Manufacturing	2	0.1		23.6	21.8	13.5	13.0
335 Total	Electrical Equipment, Appliance & Component Manufacturing	1					23.4	14.0
336 Total	Transportation Equipment Manufacturing	4	75.8	0.5	366.7	73.0	76.4	72.6
399 Total	Other Manufacturing	1	9.5	98.0	0.2	0.9	5.5	3.6
424 Total	Merchant Wholesalers, Nondurable Goods	1			181.8			
562 Total	Waste Management and Remediation Services	2	14.0		4.9		5.5	5.5
Total		**48.0**	**113,102.6**	**157,748.2**	**921.6**	**15,974.4**	**19,732.7**	**18,940.5**

Chihuahua: 1999 Point Source Emissions Inventory (Final)
Mg/year, by NAICS

		Number of Facilities	NO_x	SO_2	VOC	CO	PM	$PM_{2.5}$
212 Total	Mining (except oil & gas)	7	51.6	32.4	0.1	2.3	557.9	159.5
221 Total	Utilities	6	10,144.7	59,725.8	454.0	2,042.3	3,822.0	3,755.0
311 Total	Food Manufacturing	5	19.1	10.1	42.1	29.9	5.8	4.2
315 Total	Apparel Manufacturing	3	1,077.5	0.1	0.4	1,803.0		
321 Total	Wood Product Manufacturing	13	31.3	53.7	110.8	594.5	35.3	34.3
322 Total	Paper Manufacturing	4	323.0	4,954.4	43.0	6,150.4	1,647.9	1,252.0
325 Total	Chemical Manufacturing	9	160.7	373.2	46.4	688.7	750.4	733.7
327 Total	Nonmetallic Mineral Products Manufacturing	10	4,350.6	22.7	48.0	2,024.8	177.9	123.1
331 Total	Primary Metal Manufacturing	1	8.0	5.9			2.7	2.7
332 Total	Fabricated Metal Product Manufacturing	5	1,471.3	4.4	26.6	50.4	30.8	29.2
334 Total	Computer & Electronic Product Manufacturing	14	123.9	1.3	430.6	97.2	93.3	120.3
335 Total	Electrical Equipment, Appliance & Component Manufacturing	16	127.1	1.3	656.0	41.6	58.0	57.0
336 Total	Transportation Equipment Manufacturing	6	169.2	0.0	83.2	178.1	53.2	1.7
337 Total	Furniture & Related Product Manufacturing	1	0.1	1.3	8.5	0.1	0.1	0.1
339 Total	Miscellaneous Manufacturing	5	60.2	0.7	150.9	12.6	1.9	1.9
399 Total	Other Manufacturing	5	14.9	0.1	110.6	105.6	4.2	4.1
424 Total	Merchant Wholesalers, Nondurable Goods	2			96.9			
Total		**112**	**18,133.2**	**65,187.6**	**2,308.3**	**13,821.6**	**7,241.3**	**6,278.6**

Nuevo León: 1999 Point Source Emissions Inventory (Final)
Mg/year, by NAICS

3Digit NAICS		of Facilities	NO_x	SO_2	VOC	CO		$PM_{2.5}$
212 Total	Mining (except oil & gas)	4	384.2	1,712.2	17.1	160.9	149.8	80.1
221 Total	Utilities	10	8,563.6	38,304.7	97.7	2,051.1	2,019.2	1,983.8
311 Total	Food Manufacturing	6	257.2	280.7	13.7	133.4	49.8	11.6
312 Total	Beverage & Tobacco Product Manufacturing	1	6.7	0.0	0.6	5.6	48.7	29.2
322 Total	Paper Manufacturing	11	309.4	500.7	381.5	571.0	23.2	21.2
324 Total	Petroleum & Coal Products Manufacturing	2	4,100.4	32,993.3	17,695.4	6,861.7	2,177.8	1,415.6
325 Total	Chemical Manufacturing	31	1,862.5	618.1	1,270.4	1,972.7	1,986.5	1,926.9
326 Total	Plastics & Rubber Manufacturing	3	39.2	61.0	120.7	7.2	4.6	4.2
327 Total	Nonmetallic Mineral Products Manufacturing	14	2,319.3	6,910.6	65.1	549.9	251.3	222.6
331 Total	Primary Metal Manufacturing	12	1,276.8	536.8	70.7	8,408.5	460.3	445.5
332 Total	Fabricated Metal Product Manufacturing	14	1,161.5	109.7	472.5	325.4	102.9	94.6
333 Total	Machinery Manufacturing	4	34.0	0.1	67.6	5.0	5.5	5.0
334 Total	Computer & Electronic Product Manufacturing	5	10.5	0.1	89.6	7.6	2.6	2.6
335 Total	Electrical Equipment, Appliance & Component Manufacturing	10	113.4	0.9	273.3	1,009.5	3,138.3	2,977.5
336 Total	Transportation Equipment Manufacturing	7	89.2	2.6	34.9	10.3	176.8	161.5
339 Total	Miscellaneous Manufacturing	2	7.2	0.1	0.1	34.2	33.9	20.3
562 Total	Waste Management and Remediation Services	3	28.6	0.1	9.6	0.4	20.1	20.0
Total		**139**	**20,563.8**	**82,031.7**	**20,680.5**	**22,114.5**	**10,651.2**	**9,422.2**

Sonora: 1999 Point Source Emissions Inventory (Final)
Mg/year, by NAICS

3Digit NAICS		Number of Facilities	NO_x	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
212 Total	Mining (except oil & gas)	11	695.9	3,469.3	33.9	216.7	19,675.5	5,793.3
221 Total	Utilities	7	8,636.4	123,358.0	159.6	1,113.8	7,635.2	7,501.4
311 Total	Food Manufacturing	12	769.4	1,971.0	16.1	1,552.4	147.7	107.1
312 Total	Beverage & Tobacco Product Manufacturing	5	184.0	905.6	0.7	9.4	60.0	52.4
322 Total	Paper Manufacturing	1		26.1		2.8	0.5	0.4
326 Total	Plastics & Rubber Manufacturing	1	6.5	66.7			5.0	4.4
327 Total	Nonmetallic Mineral Products Manufacturing	3	1,634.8	12,743.9	11.5	66.1	697.9	469.8
331 Total	Primary Metal Manufacturing	3	1,021.8	14,733.8	0.0	79.8	2,611.7	763.0
335 Total	Electrical Equipment, Appliance & Component Manufacturing	1	0.4	1.1	51.5	0.5	0.0	0.0
336 Total	Transportation Equipment Manufacturing	2	15.1	0.1	554.9	10.3	47.0	45.3
424 Total	Merchant Wholesalers, Nondurable Goods	5		1.1	789.1	95.0		
Total		**51**	**12,964.2**	**157,276.7**	**1,617.2**	**3,146.8**	**30,880.6**	**14,737.2**

Tamaulipas: 1999 Point Source Emissions Inventory (Final)
Mg/year, by NAICS

3Digit NAICS		Number of Facilities	NO_X	SO_2	VOC	CO	PM_{10}	$PM_{2.5}$
212 Total	Mining (except oil & gas)	2	47.0	129.9	0.3	7.9	24.5	15.7
221 Total	Utilities	3	8,138.7	103,724.2	169.7	1,239.4	1,102.3	1,083.0
311 Total	Food Manufacturing	2	29.5	0.1	20.7		18.9	4.1
322 Total	Paper Manufacturing	1	19.5	197.0	0.1	1.8	10.9	7.1
324 Total	Petroleum & Coal Products Manufacturing	1	4,163.0	38,704.6	25,103.2	8,093.3	2,278.1	1,483.8
325 Total	Chemical Manufacturing	17	1,018.3	5,986.3	376.6	878.0	522.3	417.6
326 Total	Plastics & Rubber Manufacturing	2	1,317.6			280.4	20.0	19.8
327 Total	Nonmetallic Mineral Products Manufacturing	2	0.5	5.1	24.2	0.0	1.3	0.7
332 Total	Fabricated Metal Product Manufacturing	4	0.2	9.6	19.1	14.1	168.2	107.2
333 Total	Machinery Manufacturing	1					11.2	10.0
334 Total	Computer & Electronic Product Manufacturing	4	0.5		24.8	10.1	149.0	89.4
335 Total	Electrical Equipment, Appliance & Component Manufacturing	4	2.7		21.9	18.8	217.0	131.1
336 Total	Transportation Equipment Manufacturing	14	8.0	1.1	129.5	110.9	242.0	223.5
424 Total	Merchant Wholesalers, Nondurable Goods	3			321.5			
562 Total	Waste Management and Remediation Services	2	11.2		3.9		4.4	4.4
Total		**62**	**14,756.6**	**148,757.9**	**26,215.7**	**10,654.7**	**4,770.1**	**3,597.4**

APPENDIX C

ADDITIONAL AREA SOURCE DATA

- Area Source Category Forms

SOURCE TYPE: Area **SOURCE CATEGORY:** Industrial Fuel Combustion – Distillate

DESCRIPTION:
Industrial consumption of distillate fuel. Emission sources include boilers, furnaces, heaters, IC engines, etc.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:

- National level distillate fuel usage in the industrial sector (ERG, 2003d; PEMEX, 2003b; SENER, 2000a; SENER, 2001a; SENER, 2002a)
- National and state level employee statistics for the industrial sector (CMAP 20-39) (INEGI, 1999b)

EMISSION FACTORS:

- NO_x – 2.88 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- SO_x – 0.716 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- VOC – 0.024 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- CO – 0.6 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- PM – 0.24 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])

NOTES AND ASSUMPTIONS:

- Specific fuel type is industrial diesel (PEMEX, 2003b; ERG, 2003d).
- Bulk terminal-weighted average sulfur content of distillate fuel was calculated to be 0.038% (PEMEX, 2003e).
- Particle size fraction for PM_{10} is assumed to be 50% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Particle size fraction for $PM_{2.5}$ is assumed to be 12% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Industrial area source distillate quantities were reconciled with the industrial point source inventory by subtracting point source inventory distillate quantities from the area source distillate quantities.

SAMPLE CALCULATIONS:
Estimate annual emissions from distillate fuel oil combustion in the industrial sector in Baja California.

Industrial area source distillate usage in Baja California = 86,553,182 liters/year
Point source inventory distillate usage in Baja California = 14,902,246 liters/year
Reconciled industrial area source distillate usage = 86,553,182 – 14,902,246 = 71,650,936 liters/year

State level emissions:

Annual NO_x emissions = 2.88 kg/1,000 liters × (71,650,936 liters) = 206,355 kg = 206.4 Mg
Annual SO_x emissions = 0.716 kg/1,000 liters × (71,650,936 liters) = 51,302 kg = 51.3 Mg
Annual VOC emissions = 0.024 kg/1,000 liters × (71,650,936 liters) = 1,720 kg = 1.7 Mg
Annual CO emissions = 0.6 kg/1,000 liters × (71,650,936 liters) = 42,991 kg = 43.0 Mg
Annual PM_{10} emissions = 0.50 × 0.24 kg/1,000 liters × (71,650,936 liters) = 8,598 kg = 8.6 Mg
Annual $PM_{2.5}$ emissions = 0.12 × 0.24 kg/1,000 liters × (71,650,936 liters) = 2,064 kg = 2.1 Mg

Municipality level emissions – Mexicali:
Baja California employees in the industrial sector = 249,176
Mexicali employees in the industrial sector = 61,822

Annual NO_x emissions = 206.4 Mg × (61,822/249,176) = 51.2 Mg

Industrial Fuel Combustion – Distillate								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	206.4	51.3	1.7	43.0	8.6	2.1	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	170.5	42.4	1.4	35.5	7.1	1.7	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	356.8	88.7	3.0	74.3	14.9	3.6	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	317.7	79.0	2.7	66.2	13.2	3.2	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	22.7	5.6	0.2	4.7	0.9	0.2	0.0
27	Tabasco							
28	Tamaulipas	195.6	48.6	1.6	40.8	8.2	2.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		1,269.7	315.6	10.6	264.5	52.9	12.8	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Commercial Fuel Combustion – Distillate

DESCRIPTION:

Commercial consumption of distillate fuel (includes diesel). Emission sources include boilers, furnaces, heaters, IC engines, etc.

POLLUTANTS:

NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- National level distillate fuel usage in the commercial sector (ERG, 2003d; PEMEX, 2003b; SENER, 2000a; SENER, 2001a; SENER, 2002a)
- National and municipality level employee statistics for the commercial sector (CMAP 50-97) (INEGI, 1999b)

EMISSION FACTORS:

- NO_x – 2.4 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- SO_x – 0.6312 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- VOC – 0.0408 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- CO – 0.6 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- PM – 0.24 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])

NOTES AND ASSUMPTIONS:

- Specific fuel type is diesel (PEMEX, 2003b; ERG, 2003d).
- Bulk terminal-weighted average sulfur content of distillate fuel was calculated to be 0.037% (PEMEX, 2003e).
- Particle size fraction for PM_{10} is assumed to be 55% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Particle size fraction for $PM_{2.5}$ is assumed to be 42% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).

SAMPLE CALCULATIONS:

Estimate annual emissions from distillate fuel oil combustion in the commercial sector in Baja California.

National level emissions:
National level distillate fuel quantity used by the commercial sector = 98,013,286 liters/year

Annual NO_x emissions = 2.4 kg/1,000 liters × (98,013,286 liters) = 235,232 kg = 235.2 Mg
Annual SO_x emissions = 0.6312 kg/1,000 liters × (98,013,286 liters) = 61,866 kg = 61.9 Mg
Annual VOC emissions = 0.0408 kg/1,000 liters × (98,013,286 liters) = 3,999 kg = 4.0 Mg
Annual CO emissions = 0.6 kg/1,000 liters × (98,013,286 liters) = 58,808 kg = 58.8 Mg
Annual PM_{10} emissions = 0.55 × 0.24 kg/1,000 liters × (98,013,286 liters) = 12,938 kg = 12.9 Mg
Annual $PM_{2.5}$ emissions = 0.42 × 0.24 kg/1,000 liters × (98,013,286 liters) = 9,880 kg = 9.9 Mg

State level emissions:
National commercial sector employees = 9,173,249
Baja California commercial sector employees = 258,796

Annual NO_x emissions = 235.2 Mg × (258,796/9,173,249) = 6.6 Mg

Municipality level emissions – Mexicali:
Mexicali commercial sector employees = 70,826

Annual NO_x emissions = 6.6 Mg × (70,826/258,796) = 1.8 Mg

Commercial Fuel Combustion – Distillate								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	6.6	1.7	0.1	1.7	0.4	0.3	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	6.7	1.8	0.1	1.7	0.4	0.3	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	7.8	2.0	0.1	1.9	0.4	0.3	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	13.5	3.6	0.2	3.4	0.7	0.6	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	5.9	1.6	0.1	1.5	0.3	0.2	0.0
27	Tabasco							
28	Tamaulipas	7.5	2.0	0.1	1.9	0.4	0.3	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		48.1	12.7	0.7	12.1	2.6	2.0	0.0
National								

Activity Data Rating: B Emission Factor Rating: D Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Industrial Fuel Combustion – Residual

DESCRIPTION:
Industrial consumption of residual fuel. Emission sources include boilers, furnaces, heaters, IC engines, etc.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- National level residual fuel usage in the industrial sector (ERG, 2003d; PEMEX, 2003b; SENER, 2000a; SENER, 2001a; SENER, 2002a)
- National and municipality level employee statistics for the industrial sector (CMAP 20-39) (INEGI, 1999b)

EMISSION FACTORS:
- NO_x – 5.64 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- SO_x – 69.685 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- VOC – 0.0336 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- CO – 0.6 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- PM – 4.465 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])

NOTES AND ASSUMPTIONS:
- Specific fuel types include combustoleo, Intermedio 15, and Industrial Combustible.
- Bulk terminal-weighted average sulfur content of residual fuel was estimated to be 3.699% (combustoleo, Intermedio 15, and Industrial Combustible) (PEMEX, 2003e).
- Particle size fraction for PM_{10} is assumed to be 86% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Particle size fraction for $PM_{2.5}$ is assumed to be 56% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Industrial area source residual quantities were reconciled with the industrial point source inventory by subtracting point source inventory residual quantities from the area source residual quantities.
- Residual quantities from the point source inventory exceeded allocated industrial area source residual quantities for Sonora and Tamaulipas; area source residual quantities for these states were set to zero.

SAMPLE CALCULATIONS:
Estimate annual emissions from residual fuel oil combustion in the industrial sector in Baja California.

Industrial area source residual usage in Baja California = 265,365,361 liters/year
Point source inventory residual usage in Baja California = 88,228,761 liters/year
Reconciled industrial area source residual usage = 265,365,361 – 88,228,761 = 177,136,600 liters/year

<u>State level emissions</u>:

Annual NO_x emissions = 5.64 kg/1,000 liters × (177,136,600 liters) = 999,050 kg = 999.1 Mg
Annual SO_x emissions = 69.685 kg/1,000 liters × (177,136,600 liters) = 12,343,764 kg = 12,343.7 Mg
Annual VOC emissions = 0.0336 kg/1,000 liters × (177,136,600 liters) = 5,952 kg = 6.0 Mg
Annual CO emissions = 0.6 kg/1,000 liters × (177,136,600 liters) = 106,282 kg = 106.3 Mg
Annual PM_{10} emissions = 0.86 × 4.465 kg/1,000 liters × (177,136,600 liters) = 680,187 kg = 680.2 Mg
Annual $PM_{2.5}$ emissions = 0.56 × 4.465 kg/1,000 liters × (177,136,600 liters) = 442,912 kg = 442.9 Mg

<u>Municipality level emissions – Mexicali</u>:
Baja California industrial sector employees = 249,176
Mexicali industrial sector employees = 61,822

Annual NO_x emissions = 999.1 Mg × (61,822/249,176) = 247.9 Mg

Industrial Fuel Combustion – Residual								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	999.1	12,343.7	6.0	106.3	680.3	443.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	390.1	4,820.2	2.3	41.5	265.6	173.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	1,541.5	19,045.4	9.2	164.0	1,049.6	683.4	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	676.5	8,358.9	4.0	72.0	460.7	300.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		3,607.2	44,568.2	21.5	383.8	2,456.2	1,599.4	0.0
National								

Activity Data Rating: B Emission Factor Rating: D Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Commercial Fuel Combustion – Residual

DESCRIPTION:
Commercial consumption of residual fuel. Emission sources include boilers, furnaces, heaters, IC engines, etc.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- National level residual fuel usage in the commercial sector (ERG, 2003d; PEMEX, 2003b; SENER, 2000a; SENER, 2001a; SENER, 2002a)
- National and state level employee statistics for the commercial sector (CMAP, 50-97) (INEGI, 1999b)

EMISSION FACTORS:
- NO_x – 6.6 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- SO_x – 70.843 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- VOC – 0.1356 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- CO – 0.6 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- PM – 1.2 kg/1,000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])

NOTES AND ASSUMPTIONS:
- Specific fuel type is combustoleo.
- Bulk terminal-weighted average sulfur content of residual fuel was calculated to be 3.760% (combustoleo only) (PEMEX, 2003e).
- Particle size fraction for PM_{10} is assumed to be 62% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Particle size fraction for $PM_{2.5}$ is assumed to be 23% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).

SAMPLE CALCULATIONS:
Estimate annual emissions from residual fuel oil combustion in the commercial sector in Baja California.

<u>National level emissions</u>:
National level residual fuel quantity used by the commercial sector = 792,926,901 liters/year

Annual NO_x emissions = 6.6 kg/1,000 liters × (792,926,901 liters) = 5,233,318 kg = 5,233.3 Mg
Annual SO_x emissions = 70.843 kg/1,000 liters × (792,926,901 liters) = 56,173,245 kg = 56,173.2 Mg
Annual VOC emissions = 0.1356 kg/1,000 liters × (792,926,901 liters) = 107,521 kg = 107.5 Mg
Annual CO emissions = 0.6 kg/1,000 liters × (792,926,901 liters) = 475,756 kg = 475.8 Mg
Annual PM_{10} emissions = 0.62 × 1.2 kg/1,000 liters × (792,926,901 liters) = 589,938 kg = 589.9 Mg
Annual $PM_{2.5}$ emissions = 0.23 × 1.2 kg/1,000 liters × (792,926,901 liters) = 218,848 kg = 218.8 Mg

<u>State level emissions</u>:
National commercial sector employees = 9,173,249
Baja California commercial sector employees = 258,796

Annual NO_x emissions = 5,233.3 Mg × (258,796/9,173,249) = 147.6 Mg

<u>Municipality level emissions – Mexicali</u>:
Mexicali commercial sector employees = 70,826

Annual NO_x emissions = 147.6 Mg × (70,826/258,796) = 40.4 Mg

Commercial Fuel Combustion – Residual								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	147.6	1,584.8	3.0	13.4	16.6	6.2	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	148.7	1,595.7	3.1	13.5	16.8	6.2	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	173.0	1,857.4	3.6	15.7	19.5	7.2	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	300.3	3,223.9	6.2	27.3	33.9	12.6	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	132.3	1,420.6	2.7	12.0	14.9	5.5	0.0
27	Tabasco							
28	Tamaulipas	166.4	1,786.5	3.4	15.1	18.8	7.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		1,068.3	11,468.9	22.0	97.0	120.5	44.7	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Industrial Fuel Combustion – LPG

DESCRIPTION:
Industrial combustion of liquefied petroleum gas (LPG). Emission sources include boilers, furnaces, heaters, IC engines, etc.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:

- State level LPG usage by sector (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000b; SENER, 2001b; SENER, 2002b)
- Municipality level employee statistics for the industrial sector (CMAP 20-39) (INEGI, 1999b)

EMISSION FACTORS:

- NO_x – 2.424 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- SO_x – 0.00464 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- VOC – 0.0432 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- CO – 0.413 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- PM – 0.072 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])

NOTES AND ASSUMPTIONS:

- LPG is assumed to contain 60% propane and 40% butane.
- Sulfur content of propane and butane is assumed to be 0.4114 gr/100 ft^3.
- Emissions factor for total PM is assumed to represent PM_{10} and $PM_{2.5}$ emissions.
- Industrial area source LPG quantities were reconciled with the industrial point source inventory by subtracting point source inventory LPG quantities from the area source LPG quantities.
- LPG quantities from the point source inventory exceeded allocated industrial area source LPG quantities for Baja California and Coahuila; area source LPG quantities for these states were set to zero.

SAMPLE CALCULATIONS:

Estimate annual emissions from industrial LPG usage in Chihuahua.

Industrial area source LPG usage in Chihuahua = 37,419 m^3/year = 37,419,000 liters/year
Point source inventory LPG usage in Chihuahua = 14,334 m^3/year = 14,334,000 liters/year
Reconciled industrial area source LPG usage = 37,419,000 liters/year – 14,334,000 liters/year = 23,085,000 liters/year

<u>State level emissions</u>:
Annual NO_x emissions = 2.424 kg/1,000 liters × (23,085,000 liters) = 55,958 kg = 56.0 Mg
Annual SO_x emissions = 0.00464 kg/1,000 liters × (23,085,000 liters) = 107 kg = 0.1 Mg
Annual VOC emissions = 0.0432 kg/1,000 liters × (23,085,000 liters) = 997 kg = 1.0 Mg
Annual CO emissions = 0.413 kg/1,000 liters × (23,085,000 liters) = 9,529 kg = 9.5 Mg
Annual PM_{10} emissions = 0.072 kg/1,000 liters × (23,085,000 liters) = 1,661 kg = 1.7 Mg
Annual $PM_{2.5}$ emissions = 1.7 Mg

<u>Municipality level emissions – Ciudad Juárez</u>:
Number of employees in Chihuahua in the industrial sector = 358,243
Number of employees in Ciudad Juárez in the industrial sector = 240,958
Ratio of municipality level employees to state level employees in the industrial sector = 240,958/358,243 = 0.6726

Annual NO_x emissions = 56.0 Mg × 0.6726 = 37.6 Mg
Annual SO_x emissions = 0.1 Mg × 0.6726 = 0.1 Mg
Annual VOC emissions = 1.0 Mg × 0.6726 = 0.7 Mg
Annual CO emissions = 9.5 Mg × 0.6726 = 6.4 Mg
Annual PM_{10} emissions = 1.7 Mg × 0.6726 = 1.1 Mg
Annual $PM_{2.5}$ emissions = 1.1 Mg

Industrial Fuel Combustion – LPG								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	56.0	0.1	1.0	9.5	1.7	1.7	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	66.2	0.1	1.2	11.3	2.0	2.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	51.3	0.1	0.9	8.7	1.5	1.5	0.0
27	Tabasco							
28	Tamaulipas	57.7	0.1	1.0	9.8	1.7	1.7	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		231.2	0.4	4.1	39.3	6.9	6.9	0.0
National								

Activity Data Rating: A   Emission Factor Rating: D   Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Commercial Fuel Combustion – LPG

DESCRIPTION:

Commercial combustion of liquefied petroleum gas (LPG). Emission sources include boilers, furnaces, heaters, IC engines, etc.

POLLUTANTS:

NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- State level LPG usage by sector (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000b; SENER, 2001b; SENER, 2002b)
- Municipality level employee statistics for the commercial sector (CMAP 50-97) (INEGI, 1999b)

EMISSION FACTORS:

- NO_x – 1.752 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- SO_x – 0.00464 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- VOC – 0.0432 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- CO – 0.2424 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- PM – 0.0552 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])

NOTES AND ASSUMPTIONS:

- LPG is assumed to contain 60% propane and 40% butane.
- Sulfur content of propane fraction and butane fraction is assumed to be 0.4114 gr/100 ft^3.
- Emissions factor for total PM is assumed to represent PM_{10} and $PM_{2.5}$ emissions.

SAMPLE CALCULATIONS:

Estimate annual emissions from commercial LPG usage in Baja California.

State level emissions:
Commercial LPG usage in Baja California = 82,929 m^3/year = 82,929,000 liters/year

Annual NO_x emissions = 1.752 kg/1,000 liters × (82,929,000 liters) = 145,292 kg = 145.3 Mg
Annual SO_x emissions = 0.00464 kg/1,000 liters × (82,929,000 liters) = 385 kg = 0.4 Mg
Annual VOC emissions = 0.0432 kg/1,000 liters × (82,929,000 liters) = 3,583 kg = 3.6 Mg
Annual CO emissions = 0.2424 kg/1,000 liters × (82,929,000 liters) = 20,102 kg = 20.1 Mg
Annual PM_{10} emissions = 0.0552 kg/1,000 liters × (82,929,000 liters) = 4,578 kg = 4.6 Mg
Annual $PM_{2.5}$ emissions = 4.6 Mg

Municipality level emissions – Mexicali:
Number of employees in Mexicali in the commercial sector = 70,826
Ratio of municipality level employees to state level employees in the commercial sector = 70,826/258,796 = 0.274

Annual NO_x emissions = 145.3 Mg × 0.274 = 39.8 Mg
Annual SO_x emissions = 0.4 Mg × 0.274 = 0.1 Mg
Annual VOC emissions = 3.6 Mg × 0.274 = 1.0 Mg
Annual CO emissions = 20.1 Mg × 0.274 = 5.5 Mg
Annual PM_{10} emissions = 4.6 Mg × 0.274 = 1.3 Mg
Annual $PM_{2.5}$ emissions = 1.3 Mg

Commercial Fuel Combustion – LPG								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	145.3	0.4	3.6	20.1	4.6	4.6	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	178.5	0.5	4.4	24.7	5.6	5.6	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	205.6	0.5	5.1	28.4	6.5	6.5	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	149.9	0.4	3.7	20.8	4.7	4.7	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	140.9	0.4	3.5	19.5	4.4	4.4	0.0
27	Tabasco							
28	Tamaulipas	130.7	0.4	3.2	18.1	4.1	4.1	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		950.9	2.5	23.5	131.6	29.9	29.9	0.0
National								

Activity Data Rating: A   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Residential Fuel Combustion – LPG

DESCRIPTION:
Residential combustion of liquefied petroleum gas (LPG) for heating and cooking.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:

- State level LPG usage by sector (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000b; SENER, 2001b; SENER, 2002b)
- Municipality level household statistics (INEGI, 2000b)

EMISSION FACTORS:

- NO_x – 1.752 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- SO_x – 0.00464 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- VOC – 0.0432 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- CO – 0.2424 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- PM – 0.0552 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])

NOTES AND ASSUMPTIONS:

- LPG is assumed to contain 60% propane and 40% butane.
- Sulfur content of propane fraction and butane fraction is assumed to be 0.4114 gr/100 ft^3.
- Emissions factor for total PM is assumed to represent PM_{10} and $PM_{2.5}$ emissions.
- Residential LPG emission factors are assumed to be equivalent to commercial LPG emission factors.

SAMPLE CALCULATIONS:
Estimate annual emissions from residential LPG usage in Baja California.

State level emissions:
Residential LPG usage in Baja California = 418,326 m^3/year = 418,326,000 liters/year

Annual NO_x emissions = 1.752 kg/1,000 liters × (418,326,000 liters) = 732,907 kg = 732.9 Mg
Annual SO_x emissions = 0.00464 kg/1,000 liters × (418,326,000 liters) = 1,941 kg = 1.9 Mg
Annual VOC emissions = 0.0432 kg/1,000 liters × (418,326,000 liters) = 18,072 kg = 18.1 Mg
Annual CO emissions = 0.2424 kg/1,000 liters × (418,326,000 liters) = 101,402 kg = 101.4 Mg
Annual PM_{10} emissions = 0.0552 kg/1,000 liters × (418,326,000 liters) = 23,092 kg = 23.1 Mg
Annual $PM_{2.5}$ emissions = 23.1 Mg

Municipality level emission – Mexicali:
Number of households in Mexicali = 190,426
Ratio of municipality level households to state level households = 190,426/610,057 = 0.312

Annual NO_x emissions = 732.9 Mg × 0.312 = 228.8 Mg
Annual SO_x emissions = 1.9 Mg × 0.312 = 0.6 Mg
Annual VOC emissions = 18.1 Mg × 0.312 = 5.6 Mg
Annual CO emissions = 101.4 Mg × 0.312 = 31.7 Mg
Annual PM_{10} emissions = 23.1 Mg × 0.312 = 7.2 Mg
Annual $PM_{2.5}$ emissions = 7.2 Mg

Residential Fuel Combustion – LPG								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	732.9	1.9	18.1	101.4	23.1	23.1	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	900.6	2.4	22.2	124.6	28.4	28.4	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	1,037.0	2.8	25.6	143.5	32.7	32.7	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	756.4	2.0	18.7	104.7	23.8	23.8	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	710.6	1.9	17.5	98.3	22.4	22.4	0.0
27	Tabasco							
28	Tamaulipas	659.4	1.8	16.3	91.2	20.8	20.8	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		4,796.9	12.8	118.4	663.7	151.2	151.2	0.0
National								

Activity Data Rating: A   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Agricultural Fuel Combustion – LPG

DESCRIPTION:

Agricultural combustion of liquefied petroleum gas (LPG) for agricultural operations. Emission sources include machinery like pump sets, generators, turbines, etc.

POLLUTANTS:

NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- State level LPG usage by sector (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000b; SENER, 2001b; SENER, 2002b)
- Municipality level employee statistics in the agricultural sector (CMAP 0-20) (INEGI, 1999b)

EMISSION FACTORS:

- NO_x – 1.752 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- SO_x – 0.00464 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- VOC – 0.0432 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- CO – 0.2424 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])
- Total PM – 0.0552 kg/1,000 liters (U.S. EPA, 1995 [Section 1.5 – Updated October 1996])

NOTES AND ASSUMPTIONS:

- LPG is assumed to contain 60% propane and 40% butane.
- Sulfur content of propane fraction and butane fraction is assumed to be 0.4114 gr/100 ft^3.
- Emissions factor for total PM is assumed to represent PM_{10} and $PM_{2.5}$ emissions.
- Agricultural LPG emission factors are assumed to be equivalent to commercial LPG emission factors.

SAMPLE CALCULATIONS:

Estimate annual emissions from agricultural LPG usage in Baja California.

State level emissions:
Agricultural LPG usage in Baja California = 1,804 m^3/year = 1,804,000 liters/year

Annual NO_x emissions = 1.752 kg/1,000 liters × (1,804,000 liters) = 3,161 kg = 3.2 Mg
Annual SO_x emissions = 0.00464 kg/1,000 liters × (1,804,000 liters) = 8 kg = 0.0 Mg
Annual VOC emissions = 0.0432 kg/1,000 liters × (1,804,000 liters) = 78 kg = 0.1 Mg
Annual CO emissions = 0.2424 kg/1,000 liters × (1,804,000 liters) = 437 kg = 0.4 Mg
Annual PM_{10} emissions = 0.0552 kg/1,000 liters × (1,804,000 liters) = 100 kg = 0.1 Mg
Annual $PM_{2.5}$ emissions = 0.1 Mg

Municipality level emissions – Mexicali:
Number of employees in Mexicali in the agricultural sector = 731
Ratio of municipality level of employees to state level employees in the agricultural sector = 731/4,513 = 0.162

Annual NO_x emissions = 3.2 Mg × 0.162 = 0.5 Mg
Annual SO_x emissions = 0.0 Mg × 0.162 = 0.0 Mg
Annual VOC emissions = 0.1 Mg × 0.162 = 0.0 Mg
Annual CO emissions = 0.4 Mg × 0.162 = 0.1 Mg
Annual PM_{10} emissions = 0.1 Mg × 0.162 = 0.0 Mg
Annual $PM_{2.5}$ emissions = 0.0 Mg

Agricultural Fuel Combustion – LPG								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	3.2	0.0	0.1	0.4	0.1	0.1	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	3.9	0.0	0.1	0.5	0.1	0.1	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	4.5	0.0	0.1	0.6	0.1	0.1	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	3.3	0.0	0.1	0.5	0.1	0.1	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	3.1	0.0	0.1	0.4	0.1	0.1	0.0
27	Tabasco							
28	Tamaulipas	2.8	0.0	0.1	0.4	0.1	0.1	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		20.8	0.0	0.6	2.8	0.6	0.6	0.0
National								

Activity Data Rating: A   Emission Factor Rating: D   Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Transportation Fuel Combustion – LPG

DESCRIPTION:

Combustion of liquefied petroleum gas (LPG) by on-road motor vehicles.

POLLUTANTS:

NO_x, VOC, and CO

METHOD:

Emission factors

ACTIVITY DATA:

- State level LPG usage by sector (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000b; SENER, 2001b; SENER, 2002b)
- Population (INEGI, 2000b)

EMISSION FACTORS:

- NO_x – 20.41 g/liter (PEMEX, 1997)
- VOC – 12.58 g/liter (PEMEX, 1997)
- CO – 126.72 g/liter (PEMEX, 1997)

NOTES AND ASSUMPTIONS:

- LPG transportation fuel combustion was not included in the estimation of on-road motor vehicle emissions.
- Fuel economy was assumed to be 6.32 km/liter (PEMEX, 1997).
- LPG usage by the transportation sector was assumed to be uniform throughout the country.

SAMPLE CALCULATIONS:

Estimate annual emissions from transportation LPG usage in Baja California.

State level emissions:

Transportation LPG usage in Baja California = 71,522.14 m^3/year = 71,522,142 liters/year

Annual NO_x emissions = 20.41 g/liter × 71,522,142 liters/1,000,000 = 1,460.0 Mg
Annual VOC emissions = 12.58 g/liter × 71,522,142 liter/1,000,000 = 899.5 Mg
Annual CO emissions = 126.72 g/liter × 71,522,142 liter/1,000,000 = 9,063.3 Mg

Municipality level emission – Mexicali:

Population of Mexicali = 764,602
Population of Baja California = 2,487,367
Transportation LPG usage in Mexicali = 71,522,142 liters/year × (764,602/2,487,367) = 21,985,486 liters/year

Annual NO_x emissions = (21,985,486 liters × 20.41 g/liter)/1,000,000 = 448.8 Mg
Annual VOC emissions = (21,985,486 liters × 12.58 g/liter)/1,000,000 = 276.5 Mg
Annual CO emissions = (21,985,486 liters × 126.72 g/liter)/1,000,000 = 2,785.9 Mg

Transportation Fuel Combustion – LPG								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	1,460.0	0.0	899.5	9,063.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	1,794.1	0.0	1,105.3	11,136.8	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	2,065.8	0.0	1,272.8	12,823.5	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	1,506.7	0.0	928.3	9,352.9	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	1,415.6	0.0	872.1	8,787.1	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	1,313.6	0.0	809.3	8,154.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		9,555.8	0.0	5,887.3	59,317.3	0.0	0.0	0.0
National								

Activity Data Rating: A Emission Factor Rating: B Overall Rating: B

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Industrial Fuel Combustion – Natural Gas

DESCRIPTION:
Industrial combustion of natural gas. Emission sources include boilers, furnaces, heaters, IC engines, etc.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- Annual natural gas quantity used in the industrial sector (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000c; SENER, 2001c; SENER, 2002c)
- Fraction of natural gas used as petrochemical feedstock (SENER, 2000c)
- National and municipality level industrial employee statistics (CMAP 21-23, 29, 31, 34-39) (INEGI, 1999b)

EMISSION FACTORS:
- NO_x – 280 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1988])
- SO_x – 0.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1988])
- VOC – 5.5 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1988])
- CO – 84 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1988])
- PM_{10} – 7.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1988])
- $PM_{2.5}$ – 7.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1988])

NOTES AND ASSUMPTIONS:
- 100% natural gas usage in the industrial sector was assumed to be for combustion; 71% natural gas usage in the petrochemicals sector was assumed to be for combustion and the rest used as feedstock.
- SENER divided states into 5 major geographical zones: Northeast (NE) zone consists of Chihuahua, Durango, Coahuila, Nuevo León, and Tamaulipas; Northwest (NW) zone consists of Baja California, Baja California Sur, Sinaloa, and Sonora; Central zone consists of Distrito Federal, Hidalgo, México, Morelos, Puebla, and Tlaxcala; Central West zone consists of Aguascalientes, Colima, Guanajuato, Jalísco, Michoacán, Nayarit, Querétaro, and San Luis Potosí; and the South-Southwest zone consists of Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatán.
- Industrial area source natural gas quantities were reconciled with the industrial point source inventory by subtracting point source inventory natural gas quantities from the area source natural gas quantities.
- Natural gas quantities from the point source inventory exceeded allocated industrial area source natural gas quantities for Nuevo León; area source natural gas quantity for this state was set to zero.

SAMPLE CALCULATIONS:
Estimate annual emissions from industrial natural gas usage in Baja California.

Annual quantity of natural gas used in the industrial sector in the NW and NE zones = 161,330 10^6 ft^3
Annual quantity of natural gas used in the petrochemicals sector in the NW and NE zones = 259 10^6 ft^3
Total annual quantity of natural gas used in the NW and NE zones= 161,330 + 259 = 161,589 10^6 ft^3/year

<u>State level emissions</u>:
Total number of employees in industrial sector in the NW and NE zones = 1,605,365
Total number of employees in industrial sector in Baja California = 249,176

Baja California natural gas use = 161,589 10^6 ft^3/year × (249,176/1,605,365) = 25,081 10^6 ft^3/year = 710.3 10^6 m^3/year
Point source inventory LPG usage in Baja California = 226.7 10^6 m^3/year
Reconciled industrial area source LPG usage = 710.3 – 226.7 = 483.6 10^6 m^3/year

Annual NO_x emissions = (280 lb/10^6 ft^3) × (1 kg/2.205 lbs) × (35.31 ft^3/m^3) × 483.6 10^6 m^3 × 1 Mg/1000 kg = 2,169.5 Mg

<u>Municipality level emissions – Mexicali</u>:
Number of employees in Mexicali in the industrial sector = 61,822

Annual NO_x emissions = (61,822/249,176) × 2,169.5 Mg = 538.3 Mg

Industrial Fuel Combustion – Natural Gas								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	2,169.5	4.7	42.6	650.9	58.9	58.9	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	928.9	2.0	18.3	278.7	25.2	25.2	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	3,368.7	7.2	66.2	1,010.6	91.4	91.4	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	1,318.8	2.8	25.9	395.6	35.8	35.8	0.0
27	Tabasco							
28	Tamaulipas	1,567.8	3.4	30.8	470.3	42.6	42.6	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		9,353.7	20.1	183.8	2,806.1	253.9	253.9	0.0
National								

Activity Data Rating: B　　Emission Factor Rating: D　　Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Commercial Fuel Combustion – Natural Gas

DESCRIPTION:
Commercial combustion of natural gas. Emission sources include boilers, furnaces, heaters, IC engines, etc.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- Annual natural gas quantity used in the commercial sector (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000c; SENER, 2001c; SENER, 2002c)
- National and municipality level employee statistics for the commercial sector (CMAP 50-97) (INEGI, 1999b)

EMISSION FACTORS:
- NO_x – 100 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- SO_x – 0.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- VOC – 5.5 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- CO – 84 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- PM_{10} – 7.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- $PM_{2.5}$ – 7.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])

NOTES AND ASSUMPTIONS:
- SENER divided states into 5 major geographical zones: Northeast (NE) zone consists of Chihuahua, Durango, Coahuila, Nuevo León, and Tamaulipas; Northwest (NW) zone consists of Baja California, Baja California Sur, Sinaloa, and Sonora; Central zone consists of Distrito Federal, Hidalgo, México, Morelos, Puebla, and Tlaxcala; Central West zone consists of Aguascalientes, Colima, Guanajuato, Jalísco, Michoacán, Nayarit, Querétaro, and San Luis Potosí; and the South-Southwest zone consists of Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatán.
- In the Northeast zone, commercial/residential natural gas split was 0.254/0.746; in Northwest zone, commercial/residential split was 0.000/1.000; in the central zone the commercial/residential natural gas split was 0.833/0.167; and in the Central West zone the split was 0.5/0.5.
- In 1999, commercial natural gas distribution occurred only in the following distribution areas: Chihuahua, Juárez, Monterrey, Nuevo Laredo, Piedras Negras, Saltillo, Distrito Federal, Queretaro, and Valle Cuautitlan-Texcoco (SENER, 2000c).

SAMPLE CALCULATIONS:
Estimate annual emissions from commercial natural gas usage in Nuevo León.

State level emissions:
Annual quantity of natural gas used in the commercial sector in Nuevo León = 4,253.0 10^6 ft^3/year

Annual NO_x emissions = 100 lb/10^6 ft^3 × 4,253 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 192.9 Mg
Annual SO_x emissions = 0.6 lb/10^6 ft^3 × 4,253 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 1.2 Mg
Annual VOC emissions = 5.5 lb/10^6 ft^3 × 4,253 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 10.6 Mg
Annual CO emissions = 84 lb/10^6 ft^3 × 4,253 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 162.0 Mg
Annual PM_{10} emissions = 7.6 lb/10^6 ft^3 × 4,253 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 14.7 Mg
Annual $PM_{2.5}$ emissions = 7.6 lb/10^6 ft^3 × 4,253 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 14.7 Mg

Municipality level emissions – Monterrey:
Number of employees in Monterrey in the commercial sector = 276,643
Number of employees in Nuevo León in the commercial sector = 490,729

Annual NO_x emissions = 192.9 Mg × (276,643/490,729) = 108.7 Mg
Annual SO_x emissions = 1.2 Mg × (276,643/490,729) = 0.7 Mg
Annual VOC emissions = 10.6 Mg × (276,643/490,729) = 6.0 Mg
Annual CO emissions = 162.0 Mg × (276,643/490,729) = 91.3 Mg
Annual PM_{10} emissions = 14.7 Mg × (276,643/490,729) = 8.3 Mg
Annual $PM_{2.5}$ emissions = 14.7 Mg × (276,643/490,729) = 8.3 Mg

Commercial Fuel Combustion – Natural Gas								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	15.3	0.1	0.8	12.9	1.2	1.2	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	66.2	0.4	3.6	55.6	5.0	5.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	192.9	1.2	10.6	162.0	14.7	14.7	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	8.3	0.1	0.5	7.0	0.6	0.6	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		282.7	1.8	15.5	237.5	21.5	21.5	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Residential Fuel Combustion – Natural Gas

DESCRIPTION:

Residential combustion of natural gas for heating and cooking.

POLLUTANTS:

NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Emissions factors

ACTIVITY DATA:

- Annual natural gas quantity used in residential homes (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000c; SENER, 2001c; SENER, 2002c)
- Municipality level household statistics (INEGI, 2000b)

EMISSION FACTORS:

- NO_x – 94 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- SO_x – 0.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- VOC – 5.5 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- CO – 40 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- PM_{10} – 7.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])
- $PM_{2.5}$ – 7.6 lb/10^6 scf (U.S. EPA, 1995 [Section 1.4 – Updated July 1998])

NOTES AND ASSUMPTIONS:

- SENER divided states into 5 major geographical zones: Northeast (NE) zone consists of Chihuahua, Durango, Coahuila, Nuevo León, and Tamaulipas; Northwest (NW) zone consists of Baja California, Baja California Sur, Sinaloa, and Sonora; Central zone consists of Distrito Federal, Hidalgo, México, Morelos, Puebla, and Tlaxcala; Central west zone consists of Aguascalientes, Colima, Guanajuato, Jalísco, Michoacán, Nayarit, Querétaro, and San Luis Potosí; and the South-Southwest zone consists of Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatán.
- In the Northeast zone, commercial/residential natural gas split was 0.254/0.746; in the Northwest zone, commercial/residential split was 0.000/1.000; in the Central zone the commercial/residential natural gas split was 0.833/0.167; and in the Central-West zone the split was 0.5/0.5.
- In 1999, residential natural gas distribution only occurred in the following distribution areas: Cananea, Chihuahua, Juárez, Mexicali, Monterrey, Nuevo Laredo, Piedras Negras, Saltillo, Distrito Federal, Queretaro, and Valle Cuautitlan-Texcoco (SENER, 2000c).

SAMPLE CALCULATIONS:

Estimate annual emissions from residential natural gas usage in Nuevo León.

State level emissions:

Annual quantity of natural gas used in the residential sector in Nuevo León = 12,491 10^6 ft^3/year

Annual NO_x emissions = 94 lb/10^6 ft^3 × 12,491 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 532.5 Mg
Annual SO_x emissions = 0.6 lb/10^6 ft^3 × 12,491 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 3.4 Mg
Annual VOC emissions = 5.5 lb/10^6 ft^3 × 12,491 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 31.2 Mg
Annual CO emissions = 40 lb/10^6 ft^3 × 12,491 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 226.6 Mg
Annual PM_{10} emissions = 7.6 lb/10^6 ft^3 × 12,491 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 43.1 Mg
Annual $PM_{2.5}$ emissions = 7.6 lb/10^6 ft^3 × 12,491 10^6 ft^3/year × (1 kg/2.205 lb) × (1 Mg/1000 kg) = 43.1 Mg

Municipality level emissions – Monterrey:

Number of households in Monterrey = 256,073
Number of households in Nuevo León = 738,633

Annual NO_x emissions = 532.5 Mg × (256,073/738,633) = 184.6 Mg
Annual SO_x emissions = 3.4 Mg × (256,073/738,633) = 1.2 Mg
Annual VOC emissions = 31.2 Mg × (256,073/738,633) = 10.8 Mg
Annual CO emissions = 226.6 Mg × (256,073/738,633) = 78.6 Mg
Annual PM_{10} emissions = 43.1 Mg × (256,073/738,633) = 14.9 Mg
Annual $PM_{2.5}$ emissions = 43.1 Mg × (256,073/738,633) = 14.9 Mg

Residential Fuel Combustion – Natural Gas								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	1.1	0.0	0.1	0.5	0.1	0.1	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	42.2	0.3	2.5	18.0	3.4	3.4	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	182.8	1.2	10.7	77.8	14.8	14.8	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	532.5	3.4	31.2	226.6	43.1	43.1	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	21.4	0.1	1.3	9.1	1.7	1.7	0.0
27	Tabasco							
28	Tamaulipas	23.0	0.2	1.3	9.8	1.9	1.9	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		803.0	5.2	47.1	341.8	65.0	65.0	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Industrial Fuel Combustion – Kerosene

DESCRIPTION:
Industrial combustion of kerosene (diafano).

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- National kerosene consumption in the industrial sector (ERG, 2003d; SENER, 2000a)
- Employee statistics from the industrial sector (CMAP 20-39) (INEGI, 1999b)

EMISSION FACTORS:
- NO_x – 2.88 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- SO_x – 0.5964 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- VOC – 0.024 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- CO – 0.6 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- PM – 0.24 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])

NOTES AND ASSUMPTIONS:
- Particle size fraction for PM_{10} is assumed to be 55% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Particle size fraction for $PM_{2.5}$ is assumed to be 12% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Sulfur content of kerosene is assumed to be 0.035% by weight (PEMEX, 2003d).
- Industrial kerosene emission factors are assumed to be equivalent to industrial distillate emission factors.

SAMPLE CALCULATIONS:
Estimate the total industrial kerosene combustion emissions in Baja California.

National level emissions:
National kerosene consumption 10,664,682.1 liters/year

National annual NO_x emissions = 10,664,682.1 liters × 2.88 kg/1000 liters = 30,714 kg = 30.7 Mg

State level emissions:
National level employees in industrial sector = 4,341,114
State level employees in industrial sector = 249,176

Annual NO_x emissions = 30.7 Mg × (249,176/4,341,114) = 1.8 Mg

Municipality level emissions – Mexicali:
Municipality level employees in industrial sector = 61,822

Annual NO_x emissions = 1.8 Mg × (61,822/249,176) = 0.4 Mg

Industrial Fuel Combustion – Kerosene								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	1.8	0.4	0.0	0.4	0.1	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	1.4	0.3	0.0	0.3	0.1	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	2.5	0.6	0.0	0.5	0.1	0.1	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	2.3	0.6	0.0	0.5	0.1	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	1.0	0.2	0.0	0.2	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	1.4	0.3	0.0	0.3	0.1	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		10.4	2.4	0.0	2.2	0.5	0.1	0.0
National								

Activity Data Rating: B Emission Factor Rating: D Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Residential Fuel Combustion – Kerosene

DESCRIPTION:

Residential combustion of kerosene for cooking.

POLLUTANTS:

NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- National kerosene consumption in the residential sector (ERG, 2003d; SENER, 2000a)
- Municipality level household statistics (INEGI, 2000b)

EMISSION FACTORS:

- NO_x – 2.16 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- SO_x – 0.5964 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- VOC – 0.08556 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- CO – 0.6 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- PM – 0.048 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])

ASSUMPTIONS:

- Particle size fraction for PM_{10} is assumed to be 55% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Particle size fraction for $PM_{2.5}$ is assumed to be 42% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Sulfur content of kerosene is assumed to be 0.035% by weight (PEMEX, 2003d).

SAMPLE CALCULATIONS:

Estimate the total residential kerosene combustion emissions in Baja California.

National level emissions:
National residential kerosene consumption 32,158,546 liters/year

National annual NO_x emissions = (32,158,546 liters/1000) × 2.16 kg/1000 liters = 69,462 kg = 69.5 Mg

State level emissions:
National level number of households = 22,359,998
Number of households in Baja California = 610,057

Annual NO_x emissions = 69.5 Mg × (610,057/22,359,998) = 1.9 Mg

Municipality level emissions – Mexicali:
Number of households in the municipality of Mexicali = 190,426
Ratio of municipality level households to state level households = 190,426/610,057 = 0.3121

Annual NO_x emissions = 1.9 Mg × 0.3121 = 0.6 Mg

Residential Fuel Combustion – Kerosene								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	1.9	0.5	0.1	0.5	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	1.7	0.5	0.1	0.5	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	2.3	0.6	0.1	0.7	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	2.8	0.8	0.1	0.8	0.1	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	1.6	0.5	0.1	0.5	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	2.1	0.6	0.1	0.6	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		12.4	3.5	0.6	3.6	0.1	0.0	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Agricultural Fuel Combustion – Kerosene

DESCRIPTION:
Agricultural consumption of kerosene (diafano).

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- National kerosene consumption in the agricultural sector (ERG, 2003d; SENER, 2000a)
- Employee statistics from the agricultural sector (CMAP 0-20) (INEGI, 1999b)

EMISSION FACTORS:
- NO_x – 2.4 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- SO_x – 0.5964 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- VOC – 0.0408 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- CO – 0.6 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])
- PM – 0.24 kg/1000 liters (U.S. EPA, 1995 [Section 1.3 – Updated September 1998])

NOTES AND ASSUMPTIONS:
- Particle size fraction for PM_{10} is assumed to be 55% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Particle size fraction for $PM_{2.5}$ is assumed to be 42% of total PM (U.S. EPA, 1995 [Section 1.3 – Updated September 1998]).
- Sulfur content of kerosene is assumed to be 0.035% by weight (PEMEX, 2003d).
- Agricultural kerosene emission factors are assumed to be equivalent to commercial distillate emission factors.

SAMPLE CALCULATIONS:
Estimate the total agricultural kerosene combustion emissions in Baja California.

National level emissions:
National kerosene consumption 1,089,098.1 liters/year

National annual NO_x emissions = 1,089,098.1 liters × 2.4 kg/1000 liters = 2,613 kg = 2.6 Mg

State level emissions:
National level employees in the agricultural sector = 154,328
State level employees in the agricultural sector = 4,513

Annual NO_x emissions = 2.6 Mg × (4,513/154,328) = 0.08 Mg

Municipality level emissions – Mexicali:
Municipality level employees in the agricultural sector = 731

Annual NO_x emissions = 0.08 Mg × (731/4,513) = 0.01 Mg

Agricultural Fuel Combustion – Kerosene								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.1	0.0	0.0	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.2	0.1	0.0	0.1	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.1	0.0	0.0	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.5	0.1	0.0	0.1	0.0	0.0	0.0
National								

Activity Data Rating: B

Emission Factor Rating: D

Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Residential Fuel Combustion – Wood

DESCRIPTION:
Wood is used as a fuel in residential homes for cooking and heating.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors and annual firewood consumption

ACTIVITY DATA:
- Municipality level firewood consumption (Masera et al., 2003)

EMISSION FACTORS:
- NO_x – 1.4 kg/Mg (EIIP, 2001a)
- SO_x – 0.2 kg/Mg (EIIP, 2001a)
- VOC – 26.5 kg/Mg (EIIP, 2001a)
- CO – 115.4 kg/Mg (EIIP, 2001a)
- PM_{10} – 15.3 kg/Mg (EIIP, 2001a)

NOTES AND ASSUMPTIONS:
- The $PM_{2.5}$ fraction of PM_{10} is 0.9627 (ARB, 2002).
- Emission factors are for U.S. conventional residential woodstoves.

SAMPLE CALCULATIONS:
Estimate the total residential wood combustion emissions in Baja California.

State level emissions – Baja California: -
Annual residential wood consumption = 8,676.9 Mg (Masera et al., 2003)

Annual NO_x emissions – 8,676.9 Mg × 1.4 kg/Mg = 12,147 kg = 12.1 Mg
Annual SO_x emissions – 8,676.9 Mg × 0.2 kg/Mg = 1,735 kg = 1.7 Mg
Annual VOC emissions – 8,676.9 Mg × 26.5 kg/Mg = 229,937 kg = 229.9 Mg
Annual CO emissions – 8,676.9 Mg × 115.4 kg/Mg = 1,001,314 kg = 1,001.3 Mg
Annual PM_{10} emissions – 8,676.9 Mg × 15.3 kg/Mg = 132,756 kg = 132.8 Mg
Annual $PM_{2.5}$ emissions – 0.9627 × 132.7 Mg = 127.8 Mg

Municipality level emissions – Mexicali : -
Annual residential firewood consumption = 2859.6 Mg (Masera et al., 2003)

Annual NO_x emissions – 2,859.6 Mg × 1.4 kg/Mg = 4.0 Mg
Annual SO_x emissions – 2,859.6 Mg × 0.2 kg/Mg = 0.6 Mg
Annual VOC emissions – 2,859.6 Mg × 26.5 kg/Mg = 75.8 Mg
Annual CO emissions – 2,859.6 Mg × 115.4 kg/Mg = 330.0 Mg
Annual PM_{10} emissions – 2,859.6 Mg × 15.3 kg/Mg = 43.8 Mg
Annual $PM_{2.5}$ emissions – 43.8 Mg × 0.9627 = 42.1 Mg

Residential Fuel Combustion – Wood								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	12.1	1.7	229.9	1,001.3	132.8	127.8	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	47.4	6.8	897.9	3,910.0	518.4	499.1	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	277.7	39.7	5,256.1	22,889.0	3,034.7	2,921.5	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	80.4	11.5	1,521.6	6,626.1	878.5	845.7	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	139.9	20.0	2,648.8	11,534.8	1,529.3	1,472.3	0.0
27	Tabasco							
28	Tamaulipas	177.8	25.4	3,365.2	14,654.5	1,942.9	1,870.5	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		735.3	105.1	13,919.5	60,615.7	8,036.6	7,736.9	0.0
National								

Activity Data Rating: A   Emission Factor Rating: D   Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Industrial Fuel Combustion – Coal (Metallurgical Coke Production)

DESCRIPTION:
Destructive distillation of coal in coke ovens. Metallurgical coke is used in iron and steel industry processes.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, $PM_{2.5}$, and NH_3

METHOD:
Emission factors

ACTIVITY DATA:
- National metallurgical coal statistics (ERG, 2003d; SENER, 2000a)
- Employee statistics from the coke industry (CMAP 3540) (INEGI, 1999b)

EMISSION FACTORS:
- NO_x – 0.020 kg/Mg coal (U.S. EPA, 1995 [Section 12.2 – Updated September 2000])
- SO_x – 2.010 kg/Mg coal (U.S. EPA, 1995 [Section 12.2 – Updated September 2000])
- VOC – 2.100 kg/Mg coal (U.S. EPA, 1995 [Section 12.2 – Updated September 2000])
- CO – 0.635 kg/Mg coal (U.S. EPA, 1995 [Section 12.2 – Updated September 2000])
- PM_{10} – 3.159 kg/Mg coal (U.S. EPA, 1995 [Section 12.2 – Updated September 2000])
- $PM_{2.5}$ – 2.145 kg/Mg coal (U.S. EPA, 1995 [Section 12.2 – Updated September 2000])
- NH_3 – 0.090 kg/Mg coal (U.S. EPA, 1995 [Section 12.2 – Updated September 2000])
- Emission factors are a composite emission factor for the following processes: coal crushing, coal preheating, oven charging, oven door leaks, oven pushing, quenching, combustion stack, and coke handling.

NOTES AND ASSUMPTIONS:
- For oven door leaks, PM_{10} and $PM_{2.5}$ is assumed to be equal to total PM.
- For coal crushing, oven charging, and coke handling with cyclone, PM_{10} is assumed to be 40% of total PM and $PM_{2.5}$ is assumed to be 15% of total PM (ARB, 2002).

SAMPLE CALCULATIONS:
Estimate the total emissions from coal combustion associated with coke production in Coahuila.

National metallurgical coal consumption = 2,716,263 Mg/year

Annual NO_x emissions = 2,716,263 Mg/year × 0.02 kg/Mg = 54.3 Mg
Annual SO_x emissions = 2,716,263 Mg/year × 2.01 kg/Mg = 5,459.7 Mg
Annual VOC emissions = 2,716,263 Mg/year × 2.1 kg/Mg = 5,704.2 Mg
Annual CO emissions = 2,716,263 Mg/year × 0.635 kg/Mg = 1,724.8 Mg
Annual PM_{10} emissions = 2,716,263 Mg/year × 3.1592 kg/Mg = 8,581.2 Mg
Annual $PM_{2.5}$ emissions = 2,716,263 Mg/year × 2.1447 kg/Mg = 5,825.6 Mg
Annual NH_3 emissions = 2,716,263 Mg/year × 0.09 kg/Mg = 244.5 Mg

<u>State level emissions</u>:
Total national level employees in the coke industry = 9,818
Number of employees in the coke industry in Coahuila = 1,545

Annual NO_x emissions = 54.3 Mg × (1,545/9,818) = 8.5 Mg

<u>Municipality level emissions – Monclova</u>:
Number of employees in the municipality of Monclova in the coke industry = 1,202
Ratio of municipality level employees to state level employees in the coke industry = 1,202/1,545 = 0.778

Annual NO_x emissions = 8.5 Mg × (1,202/1,545) = 6.6 Mg

Industrial Fuel Combustion – Coal (Metallurgical Coke Production)								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	0.0	2.8	2.9	0.9	4.4	3.0	0.1
03	Baja California Sur							
04	Campeche							
05	Coahuila	8.5	859.2	897.6	271.4	1,350.4	916.7	38.5
06	Colima							
07	Chiapas							
08	Chihuahua	0.3	28.9	30.2	9.1	45.4	30.9	1.3
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	8.1	818.0	854.6	258.4	1,285.7	872.8	36.6
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.2	16.1	16.8	5.1	25.3	17.2	0.7
27	Tabasco							
28	Tamaulipas	1.4	136.8	142.9	43.2	215.0	146.0	6.1
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		18.5	1,861.8	1,945.0	588.1	2,926.2	1,986.6	83.3
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Industrial Fuel Combustion – Bagasse

DESCRIPTION:
Industrial combustion of bagasse (produced from sugar cane residue); used only in sugar processing facilities.

POLLUTANTS:
NO_x, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- National bagasse consumption (ERG, 2003d; SENER, 2000a)
- Employee statistics from the sugar industry (CMAP 3118) (INEGI, 1999b)

EMISSION FACTORS:
- NO_x – 0.6 kg/Mg (U.S. EPA, 1995 [Section 1.8 – Updated October 1996])
- PM_{10} – 0.68 kg/Mg (U.S. EPA, 1995 [Section 1.8 – Updated October 1996])

NOTES AND ASSUMPTIONS:
- $PM_{2.5}$ is equivalent to PM_{10}.
- Boilers are controlled with wet scrubbers; emission factors reflect controls.
- Industrial bagasse combustion only occurs in the 18 states with employees in the sugar industry.

SAMPLE CALCULATIONS:
Estimate the total industrial bagasse combustion emissions in Tamaulipas.

National level emissions:
National bagasse consumption 12,272,431 Mg/year

National NO_x emissions = 12,272,431 Mg/year × 0.6 kg/Mg = 7,363,459 kg = 7,363.5 Mg
National PM_{10} emissions = 12,272,431 Mg/year × 0.68 kg/Mg = 8,345,253 kg = 8,345.3 Mg
National $PM_{2.5}$ emissions = 8,345.3 Mg

State level emissions:
National level employees in the sugar industry = 32,584
State level employees in the sugar industry = 1,676

Annual NO_x emissions = 7,363.5 Mg × (1,676/32,584) = 378.7 Mg
Annual PM_{10} emissions = 8,345.3 Mg × (1,676/32,584) = 429.3 Mg
Annual $PM_{2.5}$ emissions = 429.3 Mg

Municipality level emissions – El Mante:
Municipality level employees in the sugar industry = 745

Annual NO_x emissions = 378.7 Mg × (745/1,676) = 168.3 Mg
Annual PM_{10} emissions = 429.3 Mg × (745/1,676) = 190.6 Mg
Annual $PM_{2.5}$ emissions = 190.6 Mg

Industrial Fuel Combustion – Bagasse								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	2.5	0.0	0.0	0.0	2.8	2.8	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	378.7	0.0	0.0	0.0	429.2	429.2	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		381.2	0.0	0.0	0.0	432.0	432.0	0.0
National								

Activity Data Rating: B Emission Factor Rating: D Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Locomotives

DESCRIPTION:

Emissions in this source category arise from line haul and yard operations. Line hauls locomotives travel between distant locations and yard locomotives are responsible for moving railcars within a particular railway yard.

POLLUTANTS:

NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- National railroad fuel consumption (line haul and yard) (SCT, 1999)
- National railroad track length (ESRI, 2003)
- Municipality railroad track length (ESRI, 2003)

EMISSION FACTORS:

- Line haul locomotives: NO_x – 71.33 g/liter of fuel; SO_x – 0.64 g/liter of fuel; VOC – 2.64 g/liter of fuel; CO – 7.03 g/liter of fuel; PM_{10} – 1.77 g/liter of fuel; and $PM_{2.5}$ – 1.59 g/liter of fuel (ERG, 2003e)
- Yard locomotives: NO_x – 95.64 g/liter of fuel; SO_x – 0.64 g/liter of fuel; VOC – 5.55 g/liter of fuel; CO – 10.07 g/liter of fuel; PM_{10} – 2.43 g/liter of fuel; and $PM_{2.5}$ – 2.19 g/liter of fuel (ERG, 2003e)

NOTES AND ASSUMPTIONS:

- Weighted average fuel sulfur content is 0.037% (PEMEX, 2003e).

SAMPLE CALCULATIONS:

Estimate annual emissions from locomotives in Baja California.

National line haul fuel consumption = 589,300,000 liters
National yard fuel consumption = 15,200,000 liters
National railroad track length = 18,389.0 km
State railroad track length = 152.0 km

<u>State level NO_x emissions</u>:

Emissions from line haul operations:
State line haul fuel consumption = 589,300,000 liters × (152.0 km/18,389 km) = 4,871,042 liters/year
Annual line haul NO_x emissions = 71.33 g/liter × 4,871,042 liters = 347.5 Mg

Emissions from yard operations:
State yard fuel consumption = 15,200,000 liters × (152.0 km/18,389 km) = 125,640 liters/year
Annual yard NO_x emissions = 95.64 g/liter × 125,640 liters = 12.0 Mg

Total annual NO_x emissions = Line haul emissions + Yard emissions = 347.5 + 12.0 = 359.5 Mg

<u>Municipality Level NO_x emissions – Mexicali</u>:

Railroad track length in the municipality of Mexicali = 79.1 km
Annual NO_x emissions = (79.1 km/152 km) × 359.5 Mg = 187.1 Mg

Locomotives								
State Code	State Name	Annual Emissions (Mg/yr)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	359.3	3.2	13.6	35.5	8.9	8.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	3,531.1	31.4	133.2	348.8	87.7	78.8	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	4,190.9	37.2	158.1	414.0	104.1	93.5	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	1,592.3	14.1	60.1	157.3	39.5	35.5	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	4,369.2	38.8	164.8	431.6	108.5	97.5	0.0
27	Tabasco							
28	Tamaulipas	1,562.3	13.9	58.9	154.3	38.8	34.9	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		15,605.1	138.6	588.7	1,541.5	387.5	348.2	0.0
National								

Activity Data Rating: A Emission Factor Rating: D Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Aircraft

DESCRIPTION:

Emissions from aircraft engines during approach, taxi/idle-in, taxi/idle-out, takeoff, and climb out. Only those portions of the flight that occur between ground level and the mixing height are included in the inventory.

POLLUTANTS:

NO_x, SO_x, VOC, and CO

METHOD:

Emission factors

ACTIVITY DATA:

Landing and take-off (LTO) data (incoming flights) (INEGI, 2001; INEGI, 2002a)

EMISSION FACTORS:

- Emission indexes from the International Civil Aviation Organization (ICAO) Engine Exhaust Emissions Data Bank (Radian, 1997; ICAO, 1995)

NOTES AND ASSUMPTIONS:

- Aircraft fleet composition was assumed to be 36.7% Fokker-100, 21.3% Metro-II, 28.0% DC-9, and 14.0% Airbus A-320 (domestic flights); 69.6% Boeing and 30.4% Airbus (international flights) (Strategis, 2003).
- A default time-in-mode (TIM) was assumed for the different aircraft types (Radian, 1997; U.S. EPA, 1985).
- All aircraft were assumed to be twin-engine.
- Sulfur content of 0.035% by weight was used to determine the SO_x emission factor (PEMEX, 2002d).
- LTO data were not available for some airports in Coahuila, México, Nuevo León, Oaxaca, Quintana Roo, and Yucatan.
- No airports were identified in the states of Hidalgo or Tlaxcala.

SAMPLE CALCULATIONS:

Estimate the total annual VOC emissions from aircraft in Baja California.

State level Emissions:

LTO statistics: 25,712 incoming domestic flights and 3,739 incoming international flights

Domestic fleet flights: Fokker-100 = 0.367 × 25,712 = 9,429; Metro II =0.213 × 25,712 = 5,484; DC-9 = 0.28 × 25,712 = 7,199; and Airbus = 0.14 × 25,712 = 3,600

International fleet flights: Boeing = 0.696 × 3,739 = 2,601; and Airbus = 0.304 × 3,739 = 1,138.

Annual VOC emissions = VOC emissions from domestic flights + VOC emissions from international flights.

VOC emissions from domestic flights = emissions from (Fokker-100 + Metro II + DC-9 + Airbus)

VOC emissions from Fokker-100 = take-off + climb out + approach + taxi/idle (in and out)

VOC emissions from Fokker-100 = TIM (min) × fuel flow (kg/min) × emission factor (kg/1,000 kg fuel) × number of flights × number of engines

VOC emissions from Fokker-100 = ((0.5 × 45.6 × 0.8/1,000) + (2.5 × 37.8 × 0.3/1,000) + (4.5 × 13.8 × 0.9/1,000) + (26.0 × 6.6 × 3.4/1,000)) × 9,429 flights × 2 engines = 12,934 kg = 12.9 Mg VOC

VOC emissions from domestic flights = 12.9 + 19.3 + 33.6 + 2.4 = 68.2 Mg

VOC emissions from international flights = emissions from (Boeing + Airbus) = 13.3 + 0.7 = 14.0 Mg

Annual VOC emissions = 68.2 + 14.0 = 82.2 Mg

Municipality level emissions – Mexicali:

VOC emissions from Fokker-100 = ((0.5 × 45.6 × 0.8/1,000) + (2.5 × 37.8 × 0.3/1,000) + (4.5 × 13.8 × 0.9/1,000) + (26.0 × 6.6 × 3.4/1,000)) × (5,298 × 0.3667) flights × 2 engines = 2,665.4 kg = 2.7 Mg

Total VOC emissions from domestic flights = 2.7 Mg + 4.0 Mg + 6.9 Mg + 0.5 Mg = 14.1 Mg

Total VOC emissions from international flights = 0.6 Mg + 11.4 Mg = 12.0 Mg

Total annual VOC emissions from domestic and international flights = 14.1 Mg + 12.0 Mg = 26.1 Mg

Aircraft								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	173.4	13.7	82.2	296.3	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	106.3	8.5	50.7	182.3	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	161.8	12.7	76.0	275.1	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	277.6	21.8	129.7	470.6	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	210.5	16.6	99.1	358.5	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	142.7	11.3	68.0	244.7	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		1,072.3	84.6	505.7	1,827.5	0.0	0.0	0.0
National								

Activity Data Rating: A Emission Factor Rating: C Overall Rating: C

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Commercial Marine Vessels

DESCRIPTION:

This source category includes emissions from commercial marine vessels powered either by diesel engines (distillate fuel) or steam turbines (residual fuel).

POLLUTANTS:

NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- National-level marine distillate and residual fuel usage (ERG, 2003d; PEMEX, 2003b)
- Volume of cargo handled in commercial marine ports (INEGI, 2002)

EMISSION FACTORS:

- NO_x – 6.52 kg/1000 liters (residual); 95.96 kg/1000 liters (distillate) (Billings et al., 2003; ERG, 2003e)
- SO_x – 28.20 kg/1000 liters (residual); 0.29 kg/1000 liters (distillate) (Billings et al., 2003; ERG, 2003e)
- VOC – 0.15 kg/1000 liters (residual); 0.84 kg/1000 liters (distillate) (Billings et al., 2003; ERG, 2003e)
- CO – 0.44 kg/1000 liters (residual); 9.46 kg/1000 liters (distillate) (Billings et al., 2003; ERG, 2003e)
- PM_{10} – 3.09 kg/1000 liters (residual); 2.28 kg/1000 liters (distillate) (Billings et al., 2003; ERG, 2003e)
- $PM_{2.5}$ – 3.02 kg/1000 liters (residual); 2.23 kg/1000 liters (distillate) (Billings et al., 2003; ERG, 2003e)

NOTES AND ASSUMPTIONS:

- Bulk terminal-weighted average sulfur content of distillate fuel was estimated to be 0.0399% by weight (PEMEX, 2003e).
- Bulk terminal-weighted average sulfur content of residual fuel was estimated to be 3.76% by weight (PEMEX, 2003e).
- Distillate density was assumed to be 0.845 kg/liter (U.S. EPA, 1995 [Appendix A]).
- Residual density was assumed to be 0.944 kg/liter (U.S. EPA, 1995 [Appendix A]).
- 25% of the residual fuel is assumed to be consumed by marine vessels at the port.
- 75% of the distillate fuel is assumed to be consumed by marine vessels at the port.
- PM_{10} particle size distribution is assumed to be 96% of TSP (ARB, 2002).
- $PM_{2.5}$ particle size distribution is assumed to be 97.6% of PM_{10} (ARB, 2002).
- Commercial marine port cargo statistics were unavailable for Puerto Vallarta, Playa del Carmen, Minatitlan, and Nanchital.

SAMPLE CALCULATIONS:

Estimate annual NO_x emissions from commercial marines in Baja California.

National level marine distillate fuel usage = 899,412,619 liters/year
National level marine residual fuel usage = 76,077,808 liters/year

National level emissions from commercial marine fuel usage:
Distillate fuel used in the ports = 0.75 × 899,412,619 liters/year = 674,559,464 liters/year
Residual fuel used in the ports = 0.25 × 76,077,808 liters/year = 19,019,452 liters/year

Annual NO_x emissions = [95.96 kg/1000 liters × (674,559,464 liters)] + [6.52 kg/1000 liters × (19,019,452 liters)]
= 64,854,733 kg = 64,854.7 Mg

State Level Emissions - Baja California:
Volume of cargo in ports located in Baja California = 17,668,000 Mg/yr
National volume of cargo handled = 231,440,000 Mg/yr

Annual NO_x emissions in Baja California = (17,668,000/231,440,000) × 64,854.7 Mg = 4,951.2 Mg

Municipality Level Emissions – Playas de Rosarito:
Volume of cargo handled in ports located in Playas de Rosarito = 2,828,000 Mg/yr

Annual NO_x emissions in Playas de Rosarito = (2,828,000/17,668,000) × 4,951.2 Mg = 792.5 Mg

Commercial Marine Vessels								
		Annual Emissions (Mg/yr)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	5,809.1	68.9	51.1	572.3	142.5	139.1	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	1,393.1	16.5	12.3	137.2	34.2	33.4	0.0
27	Tabasco							
28	Tamaulipas	4,397.9	52.2	38.7	433.3	107.9	105.3	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		11,600.1	137.6	102.1	1,142.8	284.6	277.8	0.0
National								

Activity Data Rating: B   Emission Factor Rating: C   Overall Rating: C

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Border Crossings

DESCRIPTION:
Emissions from motor vehicles idling at border crossings.

POLLUTANTS:
NO_x, VOC, and CO

METHOD:
Emission factors derived from MOBILE5-JuárezII, Version 5a.1 (ERG, 2002b)

ACTIVITY DATA:
- Monthly average minimum and maximum temperatures (NCDC, 2003)
- Altitude of the border crossing
- Number of vehicles at border crossing points (BTS, 1999)
- Vehicle wait times at various border crossing ports (CBP, 2003)

EMISSION FACTORS:
- MOBILE5-JuárezII (ERG, 2002b)

NOTES AND ASSUMPTIONS:
- Average vehicle speed at border crossing points is assumed to be 4 km/hr.
- Passenger vehicles were considered as light-duty gasoline vehicles (LDGV).
- Trucks and buses were grouped as heavy-duty diesel vehicles (HDDV).
- Emissions were only estimated for vehicles entering from Mexico into the United States.
- Emissions were not estimated at the Mexico-Guatemala or Mexico-Belize borders.
- There are no border crossings in the state of Nuevo León.

SAMPLE CALCULATIONS:
Estimate NO_x emissions from border crossings in Baja California.

Total emissions from border crossings in Baja California = emissions from Tijuana, Mexicali, and Tecate

Municipality level emissions – Mexicali:
NO_x emission factors for LDGV in the month of January = 3.04 g/km
Number of LDGV in January = 823,705
Average wait time for passenger vehicles = 21 minutes = 0.35 hr
NO_x emissions = 3.04 g/km × 823,705 × 4 km/hr × 0.35 hr = 3.5 Mg

NO_x emission factors for HDDV in the month of January = 18.05 g/km
Number of HDDV in January = 20,131
Average wait time for commercial vehicles = 4 minutes = 0.07 hr
NO_x emissions = 18.05 g/km × 20,131 × 4 km/hr × 0.07 hr = 0.1 Mg

Total annual emissions at the Mexicali border crossing = Σ (Emissions in each month)
Total annual NO_x emissions at the Mexicali border crossing = 39.0 Mg

State level emissions:
Total annual NO_x emissions in Baja California = NO_x emissions at Mexicali border crossing + NO_x emissions at Tijuana border crossing + NO_x emissions at Tecate border crossing

Total annual NO_x emissions at the Mexicali border crossing = 39.0 Mg
Total annual NO_x emissions at the Tecate border crossing = 4.0 Mg
Total annual NO_x emissions at the Tijuana border crossing = 78.8 Mg

Total annual NO_x emissions in Baja California from border crossings = 78.8 Mg + 39.0 Mg + 4.0 Mg = 121.8 Mg

Border Crossings								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	121.8	0.0	871.3	9,269.1	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	9.3	0.0	62.9	674.1	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	47.4	0.0	312.3	3,581.9	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	44.6	0.0	286.6	3,134.1	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	116.6	0.0	465.1	4,920.3	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		339.7	0.0	1,998.3	21,579.5	0.0	0.0	0.0
National								

Activity Data Rating: B   Emission Factor Rating: B   Overall Rating: B

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Gasoline Distribution

DESCRIPTION:

This source category relates to the emissions occurring during the transportation and distribution of gasoline. This category includes tank truck loading emissions at bulk terminals, tank truck transit losses, Stage I loading losses (from tank truck to underground tank), tank breathing, and Stage II loading losses (from underground tank to vehicle – including spillage).

POLLUTANTS:

VOC

METHOD:

Emission factors

ACTIVITY DATA:

- Gasoline quantity used in each state (PEMEX, 2003b; ERG, 2003d)
- Municipality level gas station statistics including controls (PEMEX, 2003f)

EMISSION FACTORS:

- $VOC_{Bulk\ terminal}$ – 1,430 mg/liter; $VOC_{Gas\ filled\ trucks}$ – 1 mg/liter; $VOC_{Vapor\ filled\ trucks}$ – 13 mg/liter; $VOC_{Stage\ I\ controlled}$ – 40 mg/liter; $VOC_{Stage\ I\ uncontrolled}$ – 1,380 mg/liter; $VOC_{Tank\ losses}$ – 120 mg/liter, $VOC_{Stage\ II\ controlled}$ – 132 mg/liter; $VOC_{Stage\ II\ uncontrolled}$ – 1320 mg/liter and $VOC_{Spillage}$ – 80 mg/liter (EIIP, 2001b)

NOTES AND ASSUMPTIONS:

- Splash filling was employed for tank truck filling at bulk terminals.
- Tank truck transit emissions were allocated to municipalities based on the population in those municipalities with gas stations.

SAMPLE CALCULATIONS:

Estimate annual VOC emissions from gasoline distribution in Baja California.

Annual emissions from gasoline distribution at gas stations in Baja California = Emissions from (Ensenada + Mexicali + Tecate + Tijuana + Rosarito).
National level quantity of gasoline = 29,639,056,250 liters/year

Emissions in Ensenada:

Number of gas stations in Ensenada = 44; Gas stations with stage I controls = 3; Gas stations with stage II controls = 0;
Population of Ensenada = 370,730; Total population of all municipalities with gas stations = 87,821,605
Quantity of gasoline from Ensenada bulk terminal = 237,568,126 liters/year
Quantity of gasoline from Ensenada stations = (370,730/87,821,605) x 29,639,056,250 liters = 125,118,270 liters/year

Tank truck filling emissions at bulk terminal = 237,568,126 liters x 1,430 mg/liter/10^9 = 339.7 Mg
Tank truck transit emissions = 125,118,270 x (1 mg/liter + 13 mg/liter)/10^9 = 1.8 Mg
Stage I emissions = 125,118,270 liters x ([3/44 x 40 mg/liter] + [41/44 x 1,380 mg/liter])/10^9 = 161.2 Mg
Stage II emissions (including spillage) = 125,118,270 liters x (1,320 mg/liter + 80 mg/liter)/10^9 = 175.2 Mg
Underground tank emissions = 125,118,270 liters x 120 mg/liter/10^9 = 15.0 Mg

Total Ensenada gasoline distribution emissions = 339.7 Mg + 1.8 Mg + 161.2 Mg + 175.2 Mg + 15.0 Mg = 692.9 Mg

Total emissions from gasoline distribution at gas stations in Baja California = 692.9 Mg (Ensenada) + 1,240.5 Mg (Mexicali) + 41.3 Mg (Tecate) + 643.2 Mg (Tijuana) + 1,105.9 Mg (Rosarito) = 3,723.8 Mg

Gasoline Distribution								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	0.0	0.0	3,723.8	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	2,403.7	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	3,484.8	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	4,478.0	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	2,659.7	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	3,309.7	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	20,059.7	0.0	0.0	0.0	0.0
National								

Activity Data Rating: A Emission Factor Rating: D Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** LPG Distribution

DESCRIPTION:
This source category includes emissions due to leaks and evaporative losses from LPG transport, storage, and distribution systems within the industrial, commercial, residential, agricultural, and transportation sectors.

POLLUTANTS:
VOC

METHOD:
Emission factor

ACTIVITY DATA:
State level LPG usage (ERG, 2003d; PEMEX, 2003c; SENER, 2000a; SENER, 2000b; SENER, 2001b; SENER, 2002b)

EMISSION FACTORS:
- LPG leakage emission factor – 3.6% of total LPG (PEMEX, 1997; Radian, 1997)

ASSUMPTIONS:
- LPG density was assumed to be 0.507 kg/liter (U.S. EPA, 1995 [Appendix A]).
- VOC emissions are 98.4% of TOG emissions (Radian, 1997).
- LPG transport, storage, and distribution practices throughout the entire country of Mexico are similar to those in Mexico City.

SAMPLE CALCULATIONS:
Estimate emissions from LPG distribution in Baja California.

<u>State level emissions</u>:
Annual LPG usage in Baja California = 601,026,177 liters
LPG density = 0.507 kg/liter
Sector fractions: industrial = 0.04400; commercial/transportation = 0.25698; agricultural = 0.00300; and residential = 0.69602

Annual VOC emissions in Baja California = 601,026,177 × 0.507 × 0.036 × 0.984 = 10,794,411 kg = 10,794.4 Mg

<u>Municipality level emissions – Mexicali</u>:
Annual VOC emissions from state wide industrial LPG distribution = 10,794.4 Mg × 0.04400 = 475.0 Mg
Ratio of municipality level industrial employees to state industrial employee = 61,822/249,176
Annual VOC emissions in Mexicali = (61,822/249,176) × 475 Mg = 117.8 Mg

Annual VOC emissions from state wide commercial/transportation LPG distribution = 10,794.4 Mg × 0.25698 = 2,773.9 Mg
Ratio of municipality level commercial employees to state level commercial employee = 70,826/258,796
Annual VOC emissions in Mexicali = (70,826/258,796) × 2,773.9 Mg = 759.1 Mg

Annual VOC emissions from state wide agricultural LPG distribution = 10,794.4 Mg × 0.00300 = 32.4 Mg
Ratio of municipality level agricultural employees to state level agricultural employees = 731/4,513
Annual VOC emissions in Mexicali = (731/4,513) × 32.4 Mg = 5.2 Mg

Annual VOC emissions from state wide residential LPG distribution = 10,794.4 Mg × 0.69602 = 7,513.1 Mg
Ratio of municipality level households to state level households = 190,426/610,057
Annual VOC emissions in Mexicali = (190,426/610,057) × 7,513.1 Mg = 2,345.2 Mg

Total annual emissions in Mexicali from LPG distribution = 117.8 Mg + 759.1 Mg + 5.2 Mg + 2,345.2 Mg = 3,227.4 Mg

LPG Distribution								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	0.0	0.0	10,794.4	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	13,264.3	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	15,273.3	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	11,139.7	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	10,465.8	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	9,711.7	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	70,649.2	0.0	0.0	0.0	0.0
National								

Activity Data Rating: A Emission Factor Rating: B Overall Rating: B

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Industrial Surface Coating

DESCRIPTION:
Source category includes coatings such as paints, varnish, lacquer, and paint primer. Surface coatings are applied to a wide variety of products, including furniture, cans, automobiles, airplanes and other transportation equipment, machinery, household appliances, flat wood, wire, and other miscellaneous products. In addition, coatings are used in maintenance operations at industrial facilities.

POLLUTANTS:
VOC

METHOD:
Per employee emission factors derived from Mexico paint sales.

ACTIVITY DATA:
Employee data (INEGI, 1999b)

EMISSION FACTORS:
- Per employee emission factors for different industrial sectors (kg/employee-year):

Wood furniture – 111.37
Metal furniture – 133.79
Other metallic products – 102.12
Electrical & electronic equipment – 1.51
Automotive industry – 170.64
Other transportation equipment – 116.42
Other manufacturing industries – 155.50
Industrial maintenance & surface coatings – 6.34

NOTES AND ASSUMPTIONS:
- Solvent-based paint is assumed to contain 450 g VOC/liter of paint (ANAFAPYT, 2003).
- The paint sales data provided by ANAFAPYT accounted for 90% of paint sales in Mexico; these data were extrapolated to 100%.
- Employee data used for the following industrial sectors (with CMAP codes):
  - Wood furniture – 3320 Repair and manufacturing of wooden furniture;
  - Metal furniture – 3813 Manufacturing and repair of metallic furniture;
  - Other metallic products – 3814 Manufacturing of other metallic products, excluding machinery/equipment;
  - Electrical and electronic equipment -
    - 3831 Manufacturing and/or assembly of machinery, equipment and other electrical accessories,
    - 3832 Manufacturing and/or assembly of electronic, radio, TV, communication and medical equipment;
  - Automotive industry – 3841 Automotive industry;
  - Other transportation equipment – 3842 Manufacturing, repair and/or assembly of transportation equipment and parts, excl. cars and trucks;
  - Other manufacturing industries – 39 Other manufacturing industries; and
  - Industrial maintenance and surface coatings – 3 Manufacturing industries.

SAMPLE CALCULATIONS:
Estimate the total annual VOC emissions from industrial surface coating in Baja California.

State level emissions:
Employee data:
Wood furniture – 15,259; Metal furniture – 3,218; Other metallic products – 13,389; Electrical & electronic equip. – 76,079; Automotive industry – 6,494; Other transportation equipment – 4,208; Other manufacturing industries – 12,569; Industrial maintenance & surface coatings – 248,458

Annual VOC emissions = (15,259 × 111.37) + (3,218 × 133.79) + (13,389 × 102.12) + (76,079 × 1.51) + (6,494 × 170.64) + (4,208 × 116.42) + (12,569 × 155.50) + (248,458 × 6.34) = 8,740,982 kg = 8,741.0 Mg

Municipality level emissions – Mexicali:
Annual VOC emissions = (359 × 111.37) + (823 × 133.79) + (4,940 × 102.12) + (15,778 × 1.51) + (2,984 × 170.64) + (3,763 × 116.42) + (4,394 × 155.50) + (61,375 × 6.34) = 2,698,330 kg = 2,698.3 Mg

Industrial Surface Coating								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	0.0	0.0	8,741.0	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	5,706.9	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	6,719.8	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	9,117.8	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	2,586.4	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	4,287.5	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	37,159.4	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B   Emission Factor Rating: B   Overall Rating: B

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Solvent Cleaning/Degreasing

DESCRIPTION:

Volatile organic compound emissions from surface cleaning operations. Surface cleaning operations involve the use of solvent liquids or solvent vapors to remove water-insoluble contaminants such as grease, oils, waxes, carbon deposits, fluxes, and tars from metal, plastic, glass, and other surfaces.

POLLUTANTS:

VOC

METHOD:

Per employee emission factors

ACTIVITY DATA:

- Municipality level employee statistics for the industrial manufacturing sector (CMAP 31-39) (INEGI, 1999b)

EMISSION FACTORS:

- Per employee emission factor – 39.46 kg/employee-year (EIIP, 1997)

NOTES AND ASSUMPTIONS:

- It is assumed that Mexican solvent cleaning and degreasing operations are similar to those in the U.S.

SAMPLE CALCULATIONS:

Estimate the total annual emissions from degreasing operations in Baja California.

<u>State Level Emissions – Baja California</u>:

Number of employees in manufacturing industries in Baja California = 248,458
Per employee VOC emission factor = 39.46 kg/employee/year

Annual VOC emissions = 248,458 × 39.46 kg/employee/yr =9,803,105 kg = 9,803.1 Mg

<u>Municipality Level Emissions – Mexicali</u>:

Number of employees in manufacturing industries in Mexicali = 61,375
Per capita VOC emission factor = 39.46 kg/employee/yr

Annual VOC emissions = 61,375 × 39.46 kg/employee/yr = 2,421,599 kg = 2,421.6 Mg

Solvent Cleaning/Degreasing								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	9,803.1	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	7,530.9	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	13,945.3	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	12,777.3	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	5,434.0	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	7,519.2	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	57,009.8	0.0	0.0	0.0	0.0
National								

Activity Data Rating: A Emission Factor Rating: D Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Architectural Surface Coating

DESCRIPTION:

Surface coatings such as paints, paint primer, varnish, or lacquer applied to architectural surfaces.

POLLUTANTS:

VOC

METHOD:

Per capita emission factors derived from Mexico paint sales.

ACTIVITY DATA:

Population (INEGI, 2000b)

EMISSION FACTORS:

- Per capita emission factor calculated from paint sales data – 0.507 kg/person-year (ANAFAPYT, 2003)

NOTES AND ASSUMPTIONS:

- Solvent-based paint is assumed to contain 450 g VOC/liter of paint (ANAFAPYT, 2003).
- Water-based paint is assumed to contain 88.7 g VOC/liter of paint (EIIP, 1995).
- The paint sales data provided by ANAFAPYT accounted for 90% of paint sales in Mexico (ANAFAPYT, 2003); these data were extrapolated to 100%.

SAMPLE CALCULATIONS:

Estimate the total annual VOC emissions from architectural surface coatings in Baja California.

State level emissions:
Population of Baja California = 2,487,367
Per capita VOC emission factor = 0.5073 kg/person/year

Annual VOC emissions = 2,487,367 × 0.5073 = 1,261,841 kg = 1,261.8 Mg

Municipality level emissions – Mexicali:
Population of Mexicali = 764,602
Per capita VOC emission factor = 0.5073 kg/person/year

Annual VOC emissions = 764,602 × 0.5073 = 387,883 kg = 387.9 Mg

Architectural Surface Coatings								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	0.0	0.0	1,261.9	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	1,165.8	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	1,548.8	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	1,945.1	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	1,124.7	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	1,396.7	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	8,443.0	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B Emission Factor Rating: B Overall Rating: B

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Autobody Refinishing

DESCRIPTION:

Repair and restoration of automobiles, light trucks, and other vehicle bodies. Most repair jobs include refinishing on a portion of the vehicle; new vehicle coating is excluded from this source category.

POLLUTANTS:

VOC

METHOD:

Per employee emission factors derived from Mexico paint sales.

ACTIVITY DATA:

Employee data (INEGI, 1999b)

EMISSION FACTORS:

- Per employee emission factor calculated from paint sales data – 125.76 kg/employee-year (ANAFAPYT, 2003)

NOTES AND ASSUMPTIONS:

- Solvent-based paint is assumed to contain 450 g VOC/liter of paint (ANAFAPYT, 2003).
- Paint sales data provided by ANAFAPYT accounted for 90% of paint sales in Mexico, this data was extrapolated to 100%.
- Overall thinner and solvent use allocated to specific categories based upon relative paint quantities.
- Employee data used for the automotive industry sector (CMAP code 3841) (INEGI, 1999b).

SAMPLE CALCULATIONS:

Estimate the total annual VOC emissions from autobody refinishing in Baja California.

<u>State level emissions</u>:
Number of employees in the automotive industry sector = 6,494
Per employee VOC emission factor = 125.76 kg/employee/year

Annual VOC emissions = 6,494 × 125.76 = 816,685 kg = 816.7 Mg

<u>Municipality level emissions – Mexicali</u>:
Number of employees in Mexicali in the automotive industry sector = 2,984
Per employee VOC emission factor = 125.76 kg/employee/year

Annual VOC emissions = 2,984 × 125.76 = 375,268 kg = 375.3 Mg

Autobody Refinishing								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	816.7	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	2,189.8	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	1,492.5	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	1,902.6	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	459.8	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	1,606.0	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	8,467.4	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B Emission Factor Rating: B Overall Rating: B

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Consumer Solvents

DESCRIPTION:

Personal care products (i.e., perfumes, hair sprays, etc.), automotive use products (i.e., windshield fluid, wax, glass cleaner, etc.), household cleaning products, adhesives, sealants, household pesticides, etc.

POLLUTANTS:

VOC

METHOD:

Per capita emission factors

ACTIVITY DATA:

- Population (INEGI, 2000b)

EMISSION FACTORS:

- Per capita emission factor – 3.556 kg/person-year (converted from 7.84 lbs/person-year) (EIIP, 1996a)

NOTES AND ASSUMPTIONS:

- It is assumed that Mexico per capita consumer solvent use is identical to U.S. per capita consumer solvent use.

SAMPLE CALCULATIONS:

Estimate the total annual emissions from consumer solvent usage in Baja California.

State Level Emissions – Baja California:

Population of Baja California = 2,487,367
Per capita VOC emission factor = 3.556 kg/person/year

Annual VOC emissions = 2,487,367 × 3.556 kg/person/yr = 8,843,972 kg = 8,844.0 Mg

Municipality Level Emissions – Mexicali:

Population of Mexicali = 764,602
Per capita VOC emission factor = 3.556 kg/person/yr

Annual VOC emissions = 764,602 × 3.556 kg/person/yr = 2,718,585 kg = 2,718.6 Mg

Consumer Solvents								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	8,844.0	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	8,170.9	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	10,854.8	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	13,632.5	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	7,882.6	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	9,789.2	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	59,174.0	0.0	0.0	0.0	0.0
National								

Activity Data Rating: A　　Emission Factor Rating: D　　Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Dry Cleaning

DESCRIPTION:

Solvent evaporation during dry cleaning process, from leaks in the equipment, and from solvent recovery or disposal systems. Only dry cleaning facilities using petroleum distillate organic solvents for cleaning are included in this category.

POLLUTANTS:

VOC

METHOD:

Employee statistics and per employee emission factors.

ACTIVITY DATA:

- Employee data (INEGI, 1999b)

EMISSION FACTORS:

- Per employee emission factor calculated from solvent use statistics – 317.76 kg/employee-year (CANALAVA, 2002)

NOTES AND ASSUMPTIONS:

- Specific gravity of the petroleum solvent used is assumed to be 0.667 kg/liter at 60 °F.
- Employee data used for the dry cleaning sector (CMAP code 9530) (INEGI, 1999b).

SAMPLE CALCULATIONS:

Estimate the total annual VOC emissions from dry cleaning in Baja California.

State level emissions:

Number of employees in the dry cleaning sector = 1,683
Per employee VOC emission factor = 317.76 kg/employee/year

Annual VOC emissions = 1,683 × 317.76 = 534,790.1 kg = 534.8 Mg

Municipality level emissions – Mexicali:

Number of employees in Mexicali in the dry cleaning sector = 412
Per employee VOC emissions factor = 317.76 kg/employee/year

Annual VOC emissions = 412 × 317.76 = 130,917.1 kg = 130.9 Mg

Dry Cleaning								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	534.8	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	407.7	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	401.3	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	353.7	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	246.9	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	293.0	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	2,237.4	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B Emission Factor Rating: B Overall Rating: B

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Graphic Arts

DESCRIPTION:
Various graphic arts processes including typography, offset (web and sheet), rotogravure, silk screening, and flexography.

POLLUTANTS:
VOC

METHOD:
Per capita emission factors derived from Mexico ink sales.

ACTIVITY DATA:
Population (INEGI, 2000b)

EMISSION FACTORS:
- Per capita emission factor calculated from ink sales data – 0.3676 kg/person-year (ANAFAPYT, 2004)

NOTES AND ASSUMPTIONS:
Component-specific emission rates obtained from EIIP guidance (EIIP, 1996b).

SAMPLE CALCULATIONS:
Estimate the total annual VOC emissions from architectural surface coatings in Baja California.

State level emissions:
Population of Baja California = 2,487,367
Per capita VOC emission factor = 0.3676 kg/person/year

Annual VOC emissions = 2,487,367 × 0.3676 = 914,356 kg = 914.4 Mg

Municipality level emissions – Mexicali:
Population of Mexicali = 764,602
Per capita VOC emission factor = 0.3676 kg/person/year

Annual VOC emissions = 764,602 × 0.3676 = 281,068 kg = 281.1 Mg

Graphic Arts								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	914.4	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	844.8	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	1,122.3	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	1,409.4	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	815.0	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	1,012.1	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	6,118.0	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B Emission Factor Rating: B Overall Rating: B

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Traffic Markings

DESCRIPTION:

Various emission sources in this source category include painting of centerlines, edge stripes, directional markings, and paved and unpaved surfaces to improve traffic flow. These include solvent- and water-based paints.

POLLUTANTS:

VOC

METHOD:

Material Balance

ACTIVITY DATA:

- National traffic marking sales statistics (ANAFAPYT, 2003)
- National and municipality level paved road lengths (lane-kilometers) (INEGI, 2002a)

EMISSION FACTORS:

- Not applicable

NOTES AND ASSUMPTIONS:

- The paint and thinner sales data provided by ANAFAPYT accounted for 90% of sales in Mexico, these data were extrapolated to 100%.
- The VOC content was assumed to be (0.150 kg/liter) (GDF, 2001) and 0.85 kg/liter for thinner.
- Overall thinner and solvent use allocated to traffic markings based upon relative ANAFAPYT paint quantities.
- Traffic marking use is proportional to paved road length (i.e., *pavimentada* and *revestida* classifications) (INEGI, 2002a).
- Municipality-level paved road lengths were available for 26 states; road lengths estimated using a ratio of municipality area to state area for remaining 6 states (Chiapas, Chihuahua, Distrito Federal, Guerrero, Oaxaca, and Puebla),

SAMPLE CALCULATIONS:

Estimate the total annual emissions from traffic markings in Baja California.

<u>National level emissions</u>:
Quantity of traffic markings used = (100/90) × 4,900,000 liters/year = 5,444,444 liters/year
National VOC emissions (traffic markings only) = 0.150 kg/liter × 5,444,444 liters/year = 816,667 kg/year
= 816.7 Mg/year

National thinner used (all paints) = (100/90) × 66,780,000 liters/year = 74,200,000 liters/year
National VOC (thinner – all paints) = 0.85 kg/liter × 74,200,000 liters/year = 63,070,000 kg/year
Quantity of total paints used (all paints) = 155,017,778 liters/year
National VOC emissions (thinner – traffic paints) = 63,070,000 kg/yr × ([5,444,444 liters/year]/[155,017,778 liters/year]) = 2,215.1 Mg/year
Total VOC emissions (paint plus thinner) = 816.7 Mg/year + 2,215.1 Mg/year = 3,031.8 Mg/year

<u>State level emissions</u>:
National paved road length = 237,635 km
Paved road length in Baja California = 6,805.7 km

Annual VOC emissions = (6,805.7 km/237,635 km) × 3,031.8 Mg = 86.8 Mg

<u>Municipality level emissions – Mexicali</u>:
State paved road length = 6,805.7 km
Paved road length in Mexicali = 4,057.4 km

Annual VOC emissions = (4,057.4 km/6,805.7 km) × 86.8 Mg = 51.8 Mg

Traffic Markings								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	86.8	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	107.0	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	150.8	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	92.7	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	83.0	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	98.3	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	618.6	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B Emission Factor Rating: B Overall Rating: B

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Asphalt Application

DESCRIPTION:
Asphalt application to surfaces and pavements results in hydrocarbon emissions due to evaporation.

POLLUTANTS:
VOC

METHOD:
Material balance

ACTIVITY DATA:
- National asphalt sales statistics (PEMEX, 2003g)
- National and municipality level paved road lengths (INEGI, 2002b)

EMISSION FACTORS:
- Not applicable

NOTES AND ASSUMPTIONS:
- Cutback fraction of total asphalt is assumed to be similar to the U.S. (i.e., 3.06% of total asphalt).
- Asphalt is assumed to be a medium-cure cutback.
- Diluent content is assumed to be 35% (EIIP, 2001c).
- Diluent density is assumed to be 0.8 kg/liter (EIIP, 2001c).
- Evaporated fraction of diluent is assumed to be 75% (EIIP, 2001c).
- Emissions from hot-mix and emulsified asphalts are assumed to be negligible (EIIP, 2001c).

SAMPLE CALCULATIONS:
Estimate annual emissions from asphalt application in Baja California.

National level emissions:
National asphalt usage = 1,206,976,160 liters/year
National VOC emissions = 1,206,976,160 liters/year × 0.0306 × 0.35 × 0.8 kg/liter × 0.70 = 7,755,967 kg/year
= 7,756.0 Mg/year

State level emissions:
National paved road length = 237,635 km
State paved road length = 6,805.7 km

Annual VOC emissions in Baja California = 7,756.0 Mg/year × (6,805.7 km/237,635 km) = 222.1 Mg

Municipality level emissions – Mexicali:
State paved road length = 6,805.7 km
Paved road length in Mexicali = 4,057.4 km

Annual VOC emissions in Mexicali = 222.1 Mg × (4,057.4 km/6,805.7 km) = 132.4 Mg

Asphalt Application								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	222.1	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	273.6	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	385.9	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	237.1	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	212.4	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	251.6	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	1,582.7	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B　　Emission Factor Rating: C　　Overall Rating: C

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Bakeries

DESCRIPTION:
Volatile organic compound emissions (primarily ethanol) from yeast fermentation process in bakeries.

POLLUTANTS:
VOC

METHOD:
Emission factors

ACTIVITY DATA:
- Population (INEGI, 2000b)
- Per-capita bread consumption = 25 kg/person-year (Puratos, 2004)

EMISSION FACTORS:
- VOC emission factor – 5 kg VOC/Mg baked bread (EIIP, 1999)

NOTES AND ASSUMPTIONS:
- Yeast dough mixing process is sponge dough.

SAMPLE CALCULATIONS:
Estimate the total annual emissions from bakeries in Baja California.

State Level Emissions – Baja California:

Population of Baja California = 2,487,367
Annual state wide bread consumption = 2,487,367 × 25 kg/person-year = 62,184,175 kg = 62,184.2 Mg bread
VOC emission factor = 5 kg VOC/Mg baked bread

Annual VOC emissions = 62,184.2 Mg bread × 5 kg VOC/Mg baked bread = 310,921 kg = 310.9 Mg

Municipality Level Emissions – Mexicali:

Population of Mexicali = 764,602
Annual municipality wide bread consumption = 764,602 × 25 kg/person-year = 19,115,050 kg = 19,115.0 Mg
VOC emission factor = 5 kg VOC/Mg baked bread

Annual VOC emissions = 19,115 × 5 kg VOC/Mg baked bread = 95,575 kg = 95.6 Mg

Bakeries								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	310.9	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	287.3	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	381.6	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	479.3	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	277.1	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	344.2	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	2,080.4	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B Emission Factor Rating: D Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Wastewater Treatment

DESCRIPTION:

Volatile organic compound emissions from collection, contaminant treatment, and/or storage of industrial wastewater streams. These streams are discharged into either a receiving body of water or a municipal treatment plant.

POLLUTANTS:

VOC

METHOD:

Emission factors

ACTIVITY DATA:

- National level quantity of industrial wastewater (CNA, 2003)
- Municipality level municipal treatment plant statistics (INEGI, 2002b)

EMISSION FACTORS:

- TOG – 1.3 x 10^{-5} kg/liter (Radian, 1997; U.S. EPA, 1991)

NOTES AND ASSUMPTIONS:

- VOC emissions equal TOG emissions.
- VOC emissions are allocated to municipalities based on the total installed capacity of municipal treatment plants located in each municipality.
- Emissions for the state of Jalisco are likely underestimated because statistics on total installed capacity of municipal treatment plants were limited to the Guadalajara metropolitan area.

Wastewater quantity from the following type of industries was used to estimate national VOC emissions: sugar, petroleum, services, chemical and pharmaceuticals, paper, food and beverage, beer, minerals, textiles, distilleries, coffee, leather, manufacturing industries, and metallurgical industries (CNA, 2003).

SAMPLE CALCULATIONS:

Estimate the total annual VOC emissions from industrial wastewater treatment in Baja California.

National level emissions:
Annual Quantity of industrial wastewater = 3,174,098,400 m^3/year
Annual TOG emissions = 1.3 $\times$ 10^{-5} kg/liter $\times$ 3,174,098,400,000 liters/year = 41,263,279 kg/year = 41,263.3 Mg/year
Annual VOC emissions = 41,263.3 Mg/year

State level emissions:
Total installed capacity of public treatment plants in Baja California = 4,757.0 liters/sec
National level total installed capacity of public treatment plants = 111,719.6 liters/sec
Annual VOC emissions in Baja California = 41,263.3 Mg $\times$ (4,757.0/111,719.6) = 1,757.0 Mg

Municipality level emissions – Mexicali:
Total installed capacity of public treatment plants in the municipality of Mexicali = 1,260 liters/sec
Annual VOC emissions in Mexicali = 1,757.0 Mg $\times$ (1,260.0/4,757.0) = 465.4 Mg

Wastewater Treatment								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	1,757.0	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	701.1	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	2,387.1	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	4,791.1	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	1,281.8	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	1,756.6	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	12,674.7	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Agricultural Tilling

DESCRIPTION:

Fugitive dust emissions from agricultural tilling.

POLLUTANTS:

PM_{10} and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- Total cultivated area by crop type (SAGARPA, 2003a)
- Number of hectare passes by crop type (ARB, 2003)

EMISSION FACTORS (kg/hectare-pass by crop type)**:**

- 3.45 – sorghum, wheat, barley, and oats; 3.09 – alfalfa and hay/grass; 1.84 – corn and sugarcane; 1.66 – beans and chickpeas; 1.57 – green chilis; 1.37 – coffee, oranges, coconut/copra, mango, lemon, and agave; 1.15 – avocado; and 0.00 – pasture (ARB, 2003)

NOTES AND ASSUMPTIONS:

- $PM_{2.5}$ particle size fraction of PM_{10} is 0.2217 (ARB, 2002).
- It is assumed that Mexican agricultural tilling practices (i.e., hectare-passes/hectare) are similar to San Joaquin Valley, California.

SAMPLE CALCULATIONS:

Estimate annual emissions from agricultural tilling operations in Baja California.

<u>State level emissions – Baja California</u>:

Total cultivated area for wheat = 73,919 hectares

Annual PM_{10} emissions from wheat grain = 73,919 hectares × 3.45 kg/hectare-pass × 1.2 hectare-passes/hectare
= 306,025 kg = 306.0 Mg

Annual $PM_{2.5}$ emissions from wheat grain = 306.0 Mg × 0.2217 = 67.8 Mg

Annual PM_{10} emissions from agricultural tilling operations for all crop types in Baja California = 11.7 + 1.6 + 18.0 + 306.0 + 58.7 + 0.05 + 120.8 + 2.7 + 4.2 + 0.03 + 0.02 + 9.4 + 6.2 = 539.6 Mg

Annual $PM_{2.5}$ emissions from agricultural tilling operations for all crop types in Baja California = 539.6 Mg × 0.2217
= 119.6 Mg

<u>Municipality level emissions – Mexicali</u>:

Total cultivated area for wheat = 65,031 hectares

Annual PM_{10} emissions from wheat grain = 65,031 hectares × 3.45 kg/hectare-pass × 1.2 hectare-passes/hectare
= 269,228 kg = 269.2 Mg

Annual $PM_{2.5}$ emissions from wheat grain = 269.2 Mg × 0.2217 = 59.7 Mg

Annual PM_{10} emissions from agricultural tilling operations for all crop types in Baja California = 7.4 + 1.4 + 18.0 + 269.2 + 9.9 + 0.03 + 120.8 + 4.1 + 0.01 + 0.4 = 431.3 Mg

Annual $PM_{2.5}$ emissions from agricultural tilling operations for all crop types in Baja California = 431.3 Mg × 0.2217
= 95.6 Mg

Agricultural Tilling								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	539.6	119.6	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	957.6	212.3	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	5,256.0	1,165.3	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	909.3	201.6	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	1,959.3	434.4	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	5,890.4	1,305.9	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	0.0	0.0	15,512.2	3,439.1	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Agricultural Burning

DESCRIPTION:

Emissions from burning of agricultural residue.

POLLUTANTS:

VOC, CO, PM_{10} and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- Total cultivated area by crop type (SAGARPA, 2003a)
- Fuel loading by crop type (U.S. EPA, 1995 [Section 2.5 – Updated January 1995])

EMISSION FACTORS (kg/Mg biomass burned)**:**

- Wheat – VOC: 4.5 kg/Mg; CO: 54.0 kg/Mg; and PM: 6.0 kg/Mg
- Sugarcane – VOC: 4.0 kg/Mg; CO: 35.5 kg/Mg; and PM: 2.9 kg/Mg

NOTES AND ASSUMPTIONS:

- PM_{10} particle size fraction of total PM is 0.9835 (ARB, 2002).
- $PM_{2.5}$ particle size fraction of total PM is 0.9379 (ARB, 2002).
- 2,200,000 Mg of sugarcane residue is burned in Mexico in 2002 based on an undocumented source (SAGARPA, 2003b).
- Wheat crop burn fraction is 60% for Baja California, Baja California Sur, Chihuahua, Coahuila, Durango, Nuevo León, Sonora, Sinaloa, and Tamaulipas and 30% for all other remaining states based on an undocumented source (SAGARPA, 2003b).
- Agricultural burning emissions are likely to be underestimated because burn information for other crops besides wheat and sugarcane are not available.

SAMPLE CALCULATIONS:

Estimate annual VOC emissions from agricultural burning of sugarcane and wheat in Sonora.

National level VOC emissions from sugarcane burning = 2,200,000 Mg/yr × 4 kg/Mg = 8,800 Mg/yr

<u>State level emissions – Sonora</u>:
Total cultivated area for wheat = 290,895.2 hectares
Total cultivated area for sugarcane = 25 hectares
National level cultivated area for sugarcane = 679,743.3 hectares
Wheat burn fraction = 0.6

Annual VOC emissions from sugarcane burning = (25/679,743.3) × 8,800 Mg = 0.3 Mg
Annual VOC emissions from wheat crop residue burning = (290,895.2 hectares × 0.6 × 4 Mg/hectare × 4.5 kg/Mg)/1000 = 3,141.7 Mg
Total annual VOC emissions from agricultural burning in Sonora = 0.3 Mg + 3,141.7 Mg = 3,142.0 Mg

<u>Municipality level emissions – Ures</u>:
Total cultivated area for wheat = 514 hectares
Total cultivated area for sugarcane = 25 hectares

Annual VOC emissions from wheat burning = (514 hectares × 0.6 × 4 Mg/hectare × 4.5 kg/Mg)/1000 = 5.6 Mg
Annual VOC emissions from sugarcane burning = (25/679,743.3) × 8,800 Mg = 0.3 Mg

Total annual VOC emissions from agricultural burning in the municipality of Ures = 5.6 Mg + 0.3 Mg = 5.9 Mg

Agricultural Burning								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	798.3	9,579.9	1,046.9	998.3	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	61.1	733.4	80.1	76.4	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	81.9	983.2	107.4	102.5	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	246.7	2,960.2	323.5	308.5	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	3,142.0	37,702.9	4,120.0	3,929.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	598.1	5,346.3	433.8	413.7	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	4,928.1	57,305.9	6,111.7	5,828.4	0.0
National								

Activity Data Rating: E Emission Factor Rating: D Overall Rating: E

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Livestock Ammonia

DESCRIPTION:

The sources of ammonia emissions in this category are livestock and domesticated farm and dairy animals.

POLLUTANTS:

NH_3

METHOD:

Livestock population statistics and emission factors.

ACTIVITY DATA:

- Livestock population (INEGI, 2002b)

EMISSION FACTORS:

- Dairy cows – 21.30 kg/head-year; beef cattle – 4.37 kg/head-year; pigs – 4.05 kg/head-year; sheep – 3.37 kg/head-year; goats – 6.39 kg/head-year; horses – 12.20 kg/head-year; chicken – 0.19 kg/head-year; turkeys – 0.68 kg/head-year (U.S. EPA, 1992; U.S. EPA, 2004)

ASSUMPTIONS:

- Livestock statistics represent year-round livestock populations.
- Municipality-level livestock populations were not available for the states of Chiapas, Guerrero, Nuevo León, Oaxaca, Puebla, and Sinaloa; district-level livestock population were allocated to the municipality-level based on municipality land area.
- Emission factors were developed from U.S.-based manure management train (MMT)-specific emission factors combined with a Mexico-specific distribution of MMTs (U.S. EPA, 1992; U.S. EPA, 2004).
- Chicken populations are assumed to consist of 22% layers and 78% broilers (U.S. EPA, 2004).

SAMPLE CALCULATIONS:

Estimate the total annual livestock ammonia emissions in Baja California.

State level emissions:

Emissions from dairy cows = (212,929 head) × (21.30 kg NH_3/head-year) = 4,535,415 kg = 4,534.4 Mg
Emissions from beef cattle = (208,911 head) × (4.37 kg NH_3/head-year) = 913,592 kg = 913.5 Mg
Emissions from pigs = (20,726 head) × (4.05 kg NH_3/head-year) = 83,917 kg = 83.9 Mg
Emissions from sheep = (10,044 head) × (3.37 kg NH_3/head-year) = 33,844 kg = 33.8 Mg
Emissions from goats = (21,739 head) × (6.39 kg NH_3/head-year) = 139,011 kg = 139.0 Mg
Emissions from horses = (3,599 head) × (12.20 kg NH_3/head-year) = 43,906 kg = 43.9 Mg
Emissions from chickens = (686,274 head) × (0.19 kg NH_3/head-year) = 130,827 kg = 130.8 Mg

Total annual NH_3 emissions = 4,534.4 + 913.6 + 83.9 + 33.8 + 139.0 + 43.9 + 130.8 = 5,879.5 Mg

Municipality level emissions – Mexicali:

Emissions from dairy cows = (106,330 head) × (21.30 kg NH_3/head-year) = 2,264,343 kg = 2,264.3 Mg
Emissions from beef cattle = (104,324 head) × (4.37 kg NH_3/head-year) = 456,219 kg = 456.2 Mg
Emissions from pigs = (10,472 head) × (4.05 kg NH_3/head-year) = 42,400 kg = 42.4 Mg
Emissions from sheep = (4,332 head) × (3.37 kg NH_3/head-year) = 14,597 kg = 14.6 Mg
Emissions from goats = (6,979 head) × (6.39 kg NH_3/head-year) = 44,628 kg = 44.6 Mg
Emissions from horses = (3,368 head) × (12.20 kg NH_3/head-year) = 41,088 kg = 41.1 Mg
Emissions from chickens = (440,946 head) × (0.19 kg NH_3/head-year) = 84,059 kg = 84.1 Mg

Total annual NH_3 emissions = 2,264.3 + 456.2 + 42.4 + 14.6 + 44.6 + 41.1 + 84.1 = 2,947.3 Mg

Livestock Ammonia								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	0.0	0.0	5,879.5
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	0.0	0.0	23,501.1
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	0.0	0.0	28,685.3
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	0.0	0.0	14,835.2
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	0.0	0.0	40,929.5
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	0.0	0.0	30,365.6
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	0.0	0.0	0.0	0.0	144,196.2
National								

Activity Data Rating: A Emission Factor Rating: D Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Fertilizer Application

DESCRIPTION:

Ammonia emissions from the application of nitrogen based fertilizers. The amount of ammonia emissions depend on the nitrogen content of the fertilizer.

POLLUTANTS:

NH_3

METHOD:

Emission factors

ACTIVITY DATA:

- Fertilizer annual production, imports and export statistics (SENER, 2002d)
- Municipality-level fertilized acreage (INEGI, 2002b)

EMISSION FACTORS:

- Nitrogen content (%N): NPK – 11.2%; ammonium phosphates – 15.5%; ammonium nitrate – 33.9%; ammonium sulfate – 21%; urea – 45.9%; special fertilizers (foliares) and other special fertilizers – 30% (Battye et al., 1994)
- NH_3 emission factors (kg NH_3/Mg N): NPK – 48; ammonium phosphates – 48; ammonium nitrate – 25; ammonium sulfate – 97; urea – 182; special fertilizers (foliares) and other special fertilizers – 30 (Battye et al., 1994)

NOTES AND ASSUMPTIONS:

- Special fertilizers (foliares) and other special fertilizers were assumed to contain 30% nitrogen.
- Emission factor for other straight nitrogen fertilizers was used for special fertilizers (foliares) and other special fertilizers.
- Emissions were allocated based upon municipality-level fertilized acreage.
- Municipality-level fertilized acreage was available for 18 states.
- State-level fertilized acreage only was available for 9 states (Campeche, Coahuila, Guerrero, Jalisco, Mexico, Oaxaca, Sinaloa, Sonora, and Tamaulipas); municipality-level fertilized acreage was estimated based upon municipality area.
- Fertilized acreage information was unavailable for 5 states (Chiapas, Michoacán, Nayarit, Nuevo León, and Yucatán). It was assumed that state-level fertilized acreage was equal to state-level crop acreage; municipality-level fertilized acreage was estimated based upon municipality area.

SAMPLE CALCULATIONS:

Estimate the total annual emissions from urea application in Baja California.

<u>National Level Emissions from urea application:</u>

Urea usage = production + imports – exports = 395,088 + 1,151,108 - 75,582 = 1,470,614 Mg/yr
Nitrogen content of urea = 45.9 %
NH_3 emissions = 1,470,614 Mg × 0.459 × 182 kg NH_3/Mg N = 122,852,152 kg = 122,852.2 Mg/yr

<u>State Level Emissions – Baja California</u>:

Fertilized acreage in Baja California = 183,302.1 hectares
National level fertilized acreage = 14,159,905.5 hectares
Annual NH_3 emissions from urea application = (183,302.1/14,159,905.5) × 122,852.2 Mg = 1,590.3 Mg

<u>Municipality Level Emissions – Mexicali</u>:

Fertilized acreage in the municipality of Mexicali = 155,116 hectares
Annual NH_3 emissions from urea application = (155,116/183,302.1) × 1,590.3 Mg = 1,345.8 Mg

Fertilizer Application								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	0.0	0.0	2,006.1
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	0.0	0.0	795.5
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	0.0	0.0	10,117.4
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	0.0	0.0	4,073.2
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	0.0	0.0	5,767.3
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	0.0	0.0	4,143.1
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	0.0	0.0	0.0	0.0	26,902.6
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Pesticides

DESCRIPTION:

Volatile organic compound emissions from the active and inert ingredients in pesticides. VOC emissions can occur either during application of pesticides or as a result of evaporation.

POLLUTANTS:

VOC

METHOD:

Emission factors

ACTIVITY DATA:

- Municipality level crop acreage (SAGARPA, 2003a)
- National level pesticide usage (SENER, 2002d)

EMISSION FACTORS:

- VOC emission factors (active ingredients only) – 350 kg/Mg (vapor pressure between 0.0001 mm Hg and 0.000001 mm Hg) and 580 kg/Mg (vapor pressure greater than 0.0001 mm Hg) (EIIP, 2001d)

NOTES AND ASSUMPTIONS:

- Method of pesticide application was assumed to be surface application.
- Average VOC content of inert portion was assumed to be 56% (emulsifiable concentrate) (EIIP, 2001d).
- Emissions only estimated for pesticides used in quantities greater than 200 Mg/year.
- Emissions were not estimated for pesticides that were classified as "other" or that had unknown physical properties (i.e., active and inert fraction, vapor pressure, etc.).
- Pesticide quantities were assumed to be expressed in terms of active ingredient quantities.

SAMPLE CALCULATIONS:

Estimate the total annual emissions from pesticide application in Baja California.

<u>National level emissions</u>:

Annual VOC emissions = $\Sigma(E_{a,p} + E_{i,p}) = \Sigma([Q_{a,p} \times EF_{a,p}] + [Q_{i,p} \times VOC_f])$

$E_{a,p}$ = Emissions from pesticide, p, active ingredient (Mg/yr)
$E_{i,p}$ = Emissions from pesticide, p, inert ingredient (Mg/yr)
$Q_{a,p}$ = Quantity of pesticide, p, active ingredient (Mg/yr)
$EF_{a,p}$ = Vapor pressure-based for pesticide, p, active ingredient (kg/Mg)
$Q_{i,p}$ = Quantity of pesticide, p, inert ingredient (Mg/yr)
VOC_f = VOC content in formulation (56%)

Metamidofos – (8,086 Mg active ingredient/year; 40% active and 60% inert; vapor pressure – 0.0008 mm Hg)
Emissions = (8,086 Mg × 580 kg/Mg) + (8,086 Mg × [0.60/0.40] × 0.56) = 4,689.9 Mg + 6,792.2 Mg = 11,482.1 Mg

Nationwide annual VOC emissions = Σ(All pesticides) = 23,562.9 Mg

<u>State level emissions – Baja California</u>:

Crop acreage in Baja California = 126,631.1 hectares; national crop acreage = 19,266,792 hectares
Annual VOC emissions = (126,631.1/19,266,792) × 23,562.9 Mg = 154.9 Mg

<u>Municipality level emissions – Mexicali</u>:

Crop acreage in the municipality of Mexicali = 101,443.5 hectares
Annual VOC emissions = (101,443.5/126,631.1) × 154.9 Mg = 124.1 Mg

Pesticides								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	154.9	0.0	0.0	0.0	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	240.1	0.0	0.0	0.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	1,039.4	0.0	0.0	0.0	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	377.8	0.0	0.0	0.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	515.3	0.0	0.0	0.0	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	1,616.2	0.0	0.0	0.0	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	3,943.7	0.0	0.0	0.0	0.0
National								

Activity Data Rating: B　　Emission Factor Rating: D　　Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Beef Cattle Feedlots

DESCRIPTION:

Fugitive dust generated in beef cattle feedlots and stockyards by the movement of cattle over soil dust and dried manure.

POLLUTANTS:

PM_{10} and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- Slaughtered cattle population (INEGI, 2002b)

EMISSION FACTORS:

- PM_{10} emission factor: 8.62 kg/1,000 head-day (ARB, 2003)

NOTES AND ASSUMPTIONS:

- It was assumed that all slaughtered beef cattle pass through a feedlot and are kept in the feedlot for 120 days prior to slaughter based upon various academic studies.
- Municipality-level slaughter statistics were available for 22 states.
- Rural development district-level slaughter statistics were available for Oaxaca and Sinaloa; district-level slaughter cattle population was allocated to the municipality based on land area (the municipality-to-district assignment was known).
- Rural development district-level slaughter statistics were available for México; district-level slaughter cattle population was allocated to municipalities of the same name (the municipality-to-district assignment was not known).
- State-level slaughter statistics were available for Chiapas and Guerrero; state-level cattle population was allocated to municipalities based on land area and then the state-level slaughter fraction was applied to each municipality.
- No slaughter statistics were available for Distrito Federal, Michoacán, Nuevo León, Tamaulipas, and Tlaxcala. The national-level slaughter fraction (0.2423) was applied to municipality-level cattle population for Distrito Federal, Michoacán, Tamaulipas, and Tlaxcala. For Nuevo León, the state-level cattle population was allocated to the municipality-level based on municipality land area and then the national-level slaughter fraction was applied to each municipality.
- The $PM_{2.5}$ particle size fraction of PM_{10} is 0.1142 (ARB, 2002).

SAMPLE CALCULATIONS:

Estimate the total annual PM_{10} emissions from beef cattle feedlots in Baja California

State level emissions:

Baja California slaughter cattle population = 208,911

Total PM_{10} emissions from feedlots = 208,911 × 8.63 kg/1,000 head-day × 120 days = 216.3 Mg
Total $PM_{2.5}$ emissions from feedlots = 216.3 Mg × 0.1142 = 24.7 Mg

Municipality level emissions – Mexicali:

Slaughter cattle population in Mexicali = 162,962

Total PM_{10} emissions from feedlots = 162,962 × 8.63 Mg/1,000 head-day × 120 days = 168.8 Mg
Total $PM_{2.5}$ emissions from feedlots = 168.8 Mg × 0.1142 = 19.3 Mg

Beef Cattle Feedlots								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	216.2	24.7	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	205.3	23.5	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	209.3	23.9	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	94.2	10.8	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	199.0	22.7	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	295.1	33.7	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	0.0	0.0	1,219.1	139.3	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Brick Kilns

DESCRIPTION:

Emissions from this source category result from wood combustion in brick kilns. Wood is the predominant fuel in brick kilns in Mexico.

POLLUTANTS:

NO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- Annual brick production in each state (INE, 2000; ETM, 2003)

EMISSION FACTORS:

- NO_x – 4.74 kg/burn; VOC – 61.79 kg/burn; CO – 279.89 kg/burn; and total PM – 44.87 kg/burn (TCEQ, 2002)

NOTES AND ASSUMPTIONS:

- Average number of bricks produced per burn was assumed to be 7,614 (ETM, 2003).
- Particle size fraction for PM_{10} was assumed to be 0.9350 of total PM (ARB, 2002).
- Particle size fraction for $PM_{2.5}$ was assumed to be 0.9001 of total PM (ARB, 2002).

SAMPLE CALCULATIONS:

Estimate annual emissions from brick kilns in Baja California.

<u>State level emissions – Baja California</u>:

Annual brick production in Baja California = 2,400,000 bricks/year
Average bricks produced per burn = 7,614 bricks/burn
Number of burns = 2,400,000/7,614 = 315.21 burns/year

Annual NO_x emissions = 4.74 kg/burn × 315.21 burns/year = 1,494 kg = 1.5 Mg
Annual VOC emissions = 61.79 kg/burn × 315.21 burns/year = 19,476 kg = 19.5 Mg
Annual CO emissions = 279.89 kg/burn × 315.21 burns/year = 88,221 kg = 88.2 Mg
Annual TSP emissions = 44.87 kg/burn × 315.21 burns/year = 14,143 kg = 14.1 Mg
Annual PM_{10} emissions = 14.14 Mg × 0.9350 = 13.2 Mg
Annual $PM_{2.5}$ emissions = 14.14 Mg × 0.9001 = 12.7 Mg

<u>Municipality level emissions – Mexicali</u>:

Population of Mexicali = 764,602
Population of Baja California = 2,487,367

Annual NO_x emissions = (764,602/2,487,367) × 1.5 Mg = 0.5 Mg
Annual VOC emissions = (764,602/2,487,367) × 19.5 Mg = 6.0 Mg
Annual CO emissions = (764,602/2,487,367) × 88.2 Mg = 27.1 Mg
Annual PM_{10} emissions = (764,602/2,487,367) × 13.2 Mg = 4.1 Mg
Annual $PM_{2.5}$ emissions = (764,602/2,487,367) × 12.7 Mg = 3.9 Mg

Brick Kilns								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	1.5	0.0	19.5	88.2	13.2	12.7	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.6	0.0	7.8	35.3	5.3	5.1	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	26.1	0.0	339.8	1,539.1	230.7	222.1	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	2.6	0.0	33.6	152.2	22.8	22.0	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.4	0.0	4.9	22.1	3.3	3.2	0.0
27	Tabasco							
28	Tamaulipas	0.6	0.0	7.8	35.3	5.3	5.1	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		31.8	0.0	413.4	1,872.2	280.6	270.2	0.0
National								

Activity Data Rating: D   Emission Factor Rating: B   Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Street Vendors – Charbroiling

DESCRIPTION:

Emissions from charbroiling of meat.

POLLUTANTS:

NO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:

Per capita emission factors derived from previous street vendor study in Ciudad Juárez, Chihuahua.

ACTIVITY DATA:

- Population (INEGI, 2002b)

EMISSION FACTORS:

- Per capita emission factors calculated from previous street vendor study in Ciudad Juárez : NO_x – 2.93 kg/1000 people; VOC – 10.27 kg/1000 people; CO – 159.17 kg/1000 people; PM_{10} – 79.95 kg/1000 people; and $PM_{2.5}$ – 63.81 kg/1000 people (CICA, 1999; ERG, 2003f)
- LPG usage: chicken, lamb, and/or pork – VOC: 1.8 g/kg of meat; PM_{10}: 10.4 g/kg of meat (CICA, 1999)

NOTES AND ASSUMPTIONS:

- $PM_{2.5}$ particle size fraction is 0.7981 of PM_{10} (CICA, 1999).
- National emissions derived by extrapolating Ciudad Juárez emissions inventory results (ERG, 2003f).

SAMPLE CALCULATIONS:

Estimate annual emissions from charbroiling of meat by street vendors in Baja California.

National level emissions:
Total NO_x emissions in Ciudad Juárez = 3.576 Mg/year
Population of Juárez = 1,218,817
Population of Mexico = 97,483,412
Extrapolated national level NO_x emissions = (97,483,412/1,218,817) × 3.576 Mg = 286.0 Mg

State level emissions:
Baja California population = 2,487,367

NO_x emissions = 287.8 Mg/year × (2,487,367/97,483,412) = 7.3 Mg

Municipality level emissions – Mexicali:
Mexicali population = 764,602

NO_x emissions = 7.3 Mg × (764,602/2,487,367) = 2.2 Mg

Street Vendors – Charbroiling								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	7.3	0.0	25.5	395.9	198.9	158.7	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	6.7	0.0	23.6	365.8	183.7	146.6	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	9.0	0.0	31.4	485.9	244.1	194.8	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	11.2	0.0	39.4	610.3	306.5	244.7	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	6.5	0.0	22.8	352.9	177.2	141.5	0.0
27	Tabasco							
28	Tamaulipas	8.1	0.0	28.3	438.2	220.1	175.7	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		48.8	0.0	171.0	2,649.0	1,330.5	1,062.0	0.0
National								

Activity Data Rating: D Emission Factor Rating: B Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Open Burning - Waste

DESCRIPTION:
This category includes emissions resulting from open burning of solid municipal residential waste. This category does not include agricultural burning and confined burning of solid waste.

POLLUTANTS:
NO_x, SO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- Waste quantity burned (García Gutiérrez et al., 2001)
- Combustible content in waste (García Gutiérrez et al., 2001)

EMISSION FACTORS:
- NO_x – 3 kg/Mg waste; SO_x – 0.5 kg/Mg waste; VOC – 15 kg/Mg waste; CO – 42.5 kg/Mg waste; PM_{10} – 19 kg/Mg waste; and $PM_{2.5}$ – 17.4 kg/Mg waste (EIIP, 2001e)

NOTES AND ASSUMPTIONS:
- The identified state-level burned waste quantities included cardboard, fine wastes, rubber, paper, plastic film, hard plastic, garden wastes, and rags. These quantities were adjusted to account for the "other waste" category. The non-combustible portion of waste included bone, cans, ferrous and non-ferrous metals, food wastes, colored glass, and transparent glass.
- Waste compositions were developed for five different zones: Frontier North (Baja California, Coahuila, Chihuahua, Nuevo León, Sonora, and Tamaulipas); North (Aguascalientes, Baja California Sur, Colima, Durango, Jalisco, Nayarit, San Luis Potosí, Sinaloa, and Zacatecas); South (Campeche, Chiapas, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatán); Central (Guanajuato, Guerrero, Hidalgo, Michoacán, Morelos, Puebla, Querétaro, and Tlaxcala); and DF (Distrito Federal and México).

SAMPLE CALCULATIONS:
Estimate annual emissions from open burning of solid waste in Baja California.

Identified waste quantity burned = 24,363 Mg/yr (43.51% of combustibles)
Revised combustible fraction to include "other wastes" (61.56%) for Frontier North zone

Revised waste quantity burned 24,363 × (0.6156/0.4351) = 34,469.9 Mg/yr

<u>State level emissions – Baja California</u>:

Annual NO_x emissions = 3 kg/Mg × 34,469.9 Mg = 103,410 kg = 103.4 Mg
Annual SO_x emissions = 0.5 kg/Mg × 34,469.9 Mg = 17,235 kg = 17.2 Mg
Annual VOC emissions = 15 kg/Mg × 34,469.9 Mg = 517,049 kg = 517.0 Mg
Annual CO emissions = 42.5 kg/Mg × 34,469.9 Mg = 1,464,971 kg = 1,465.0 Mg
Annual PM_{10} emissions = 19 kg/Mg × 34,469.9 Mg = 654,928 kg = 654.9 Mg
Annual $PM_{2.5}$ emissions = 17.4 kg/Mg × 34,469.9 Mg = 599,776 kg = 599.8 Mg

<u>Municipality Level Emissions – Mexicali</u>:

Population of Baja California: 2,487,367; population of Mexicali: 764,602

Annual NO_x emissions = 103.4 Mg × (764,602/2,487,367) = 31.8 Mg
Annual SO_x emissions = 17.2 Mg × (764,602/2,487,367) = 5.3 Mg
Annual VOC emissions = 517.0 Mg × (764,602/2,487,367) = 158.9 Mg
Annual CO emissions = 1,465.0 Mg × (764,602/2,487,367) = 450.3 Mg
Annual PM_{10} emissions = 654.9 Mg × (764,602/2,487,367) = 201.3 Mg
Annual $PM_{2.5}$ emissions = 599.8 Mg × (764,602/2,487,367) = 184.4 Mg

Open Burning – Waste								
		Annual Emissions (Mg/yr)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	103.4	17.2	147.5	1,465.0	654.9	599.8	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	95.4	15.9	136.1	1,352.0	604.4	553.5	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	126.7	21.1	180.7	1,794.9	802.4	734.8	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	159.1	26.5	226.8	2,253.2	1,007.3	922.5	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	92.0	15.3	131.2	1,303.5	582.7	533.7	0.0
27	Tabasco							
28	Tamaulipas	114.2	19.0	162.8	1,617.8	723.2	662.3	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		690.8	115.0	985.1	9,786.4	4,374.9	4,006.6	0.0
National								

Activity Data Rating: B Emission Factor Rating: D Overall Rating: D

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Wildfires

DESCRIPTION:
This category includes forest fires, brush fires, intentional fires, and naturally occurring fires. Emissions are caused by the combustion of biomass.

POLLUTANTS:
NO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- Burned acreage per year (INEGI, 2001)
- Distribution of forest types (García Gutiérrez et al., 2001)
- Fuel loading (biomass burned) (García Gutiérrez et al., 2001)

EMISSION FACTORS:
- NO_x – 2 kg/Mg biomass; VOC – 12 kg/Mg biomass; CO – 70 kg/Mg biomass; and total PM – 8.5 kg/Mg biomass (U.S. EPA, 1995 [Section 13.1 – Updated October 1996])

NOTES AND ASSUMPTIONS:
- Particle size fraction for PM_{10} = 0.961 of total PM (ARB, 2002).
- Particle size distribution for $PM_{2.5}$ = 0.8544 of total PM (ARB, 2002).

SAMPLE CALCULATIONS:
Estimate annual emissions from wildfires in Baja California.

Municipality level emissions – Ensenada:
Area of pastures burned = 358.85 hectares/year; Area of brushwood burned = 791.52 hectares/year
Area of forests (woodland and reforested) burned = 5.05 hectares/year
Forest distribution in Baja California = conifers (100%)

Fuel loading:
Fuel loading from pasture = 1.5 Mg/hectare × 358.85 hectares = 538.3 Mg
Fuel loading from brushwood = 5 Mg/hectare × 791.52 hectares = 3,957.6 Mg
Fuel loading from coniferous forest = 120 Mg/hectare × 5.05 hectares = 606 Mg
Total fuel loading = 538.3 + 3,957.6 + 606 = 5,101.9 Mg

Annual NO_x emissions = 2 kg/Mg × 5,101.9 Mg = 10,203 kg = 10.2 Mg
Annual VOC emissions = 12 kg/Mg × 5,101.9 Mg = 61,222 kg = 61.2 Mg
Annual CO emissions = 70 kg/Mg × 5,101.9 Mg = 357,133 kg = 357.1 Mg
Annual PM_{10} emissions = 8.5 kg/Mg × 0.961 × 5,101.9 Mg = 41,674 kg = 41.7 Mg
Annual $PM_{2.5}$ emissions = 8.5 kg/Mg × 0.8544 × 5,101.9 Mg = 37,052 kg = 37.1 Mg

State level emissions – Baja California:
Annual emissions = Emissions (Ensenada + Mexicali + Tecate + Tijuana + Playas de Rosarita)

Annual NO_x emissions = 10.2 Mg + 0 Mg + 5.6 Mg + 1.2 Mg + 0.7 Mg = 17.7 Mg
Annual VOC emissions = 61.2 Mg + 0 Mg + 33.6 Mg + 7.2 Mg + 4.2 Mg = 106.2 Mg
Annual CO emissions = 357.1 Mg + 0 Mg + 195.7 Mg + 41.9 Mg + 24.6 Mg = 619.3 Mg
Annual PM_{10} emissions = 41.7 Mg + 0 Mg + 22.8 Mg + 4.9 Mg + 2.9 Mg = 72.3 Mg
Annual $PM_{2.5}$ emissions = 37.1 Mg + 0 Mg + 20.3 Mg + 4.3 Mg + 2.6 Mg = 64.3 Mg

Wildfires								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	17.7	0.0	106.2	619.4	72.3	64.3	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	23.8	0.0	142.8	833.2	97.2	86.4	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	171.5	0.0	1,029.3	6,004.2	700.6	622.9	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	5.6	0.0	33.9	197.6	23.1	20.5	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	38.4	0.0	230.4	1,343.9	156.8	139.4	0.0
27	Tabasco							
28	Tamaulipas	9.2	0.0	55.3	322.7	37.7	33.5	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		266.2	0.0	1,597.9	9,321.0	1,087.7	967.0	0.0
National								

Activity Data Rating: B   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Structure Fires

DESCRIPTION:
Structure fires include the unintentional burning of the structure material and building contents.

POLLUTANTS:
NO_x, VOC, CO, PM_{10}, and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- Housing data (INEGI, 2000b)

EMISSION FACTORS:
- NO_x – 2.0 kg/Mg (Radian, 1997; EIIP, 2001f)
- VOC – 5.21 kg/Mg (Radian, 1997; EIIP, 2001f)
- CO – 84.0 kg/Mg (Radian, 1997; EIIP, 2001f)
- PM_{10} – 5.29 kg/Mg (Radian, 1997; EIIP, 2001f)
- $PM_{2.5}$ – 4.94 kg/Mg (Radian, 1997; EIIP, 2001f)

NOTES AND ASSUMPTIONS:
- Number of fires per 1,000 houses = 0.57 (average value calculated for 19 states; INEGI, 2001).
- Average content loss was assumed to be 7.3% (Radian, 1997; EIIP, 2001f).
- Average amount of combustible contents in the structure was assumed to be 38.62 kg/m^2 (Radian, 1997; EIIP, 2001f).
- Average area of a structure was assumed to be 100 m^2.
- Only residential building fires were considered.
- Combustible building material was assumed to be 0 Mg (masonry construction) (GDF, 2003).
- PM_{10} size fraction of total PM = 0.9800; $PM_{2.5}$ size fraction of PM_{10} = 0.9327 (ARB, 2002).

SAMPLE CALCULATIONS:
Estimate the total annual emissions from structure fires in Baja California.

<u>State level emissions</u>:
Number of houses in the state of Baja California = 610,057
Number of fires = (610,057/1,000) × 0.57 = 348
Total combustible material = number of fires × structural loss × (combustible building material + combustible building contents) = 348 × (0.073) × (0 + 100 m^2 × 38.62 kg/m^2) = 98.1 Mg

Annual NO_x emissions = 98.1 Mg × 2.0 kg/Mg = 196 kg = 0.2 Mg

<u>Municipality Level emissions – Mexicali</u>:
Number of houses in the municipality of Mexicali = 190,426
Number of fires = (190,426/1000) × 0.57 = 109
Total combustible material = 109 × 0.073 × (0 + 100 m^2 × 38.62 kg/m^2) = 30.6 Mg

Annual NO_x emissions = 30.6 Mg × 2.0 kg/Mg = 61 kg = 0.06 Mg

Structure Fires								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.2	0.0	0.5	8.2	0.5	0.5	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.2	0.0	0.5	7.3	0.5	0.4	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.2	0.0	0.6	10.2	0.6	0.6	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.3	0.0	0.7	11.9	0.8	0.7	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.2	0.0	0.4	7.1	0.4	0.4	0.0
27	Tabasco							
28	Tamaulipas	0.2	0.0	0.6	9.2	0.6	0.5	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		1.3	0.0	3.3	53.9	3.4	3.1	0.0
National								

Activity Data Rating: C   Emission Factor Rating: D   Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Construction Activities

DESCRIPTION:

Building, road and other construction activities are a potentially significant source of fugitive PM emissions. Construction activities also include land clearing, drilling, blasting, ground excavation, earth moving, etc.

POLLUTANTS:

PM_{10}, and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- Construction permit data (INEGI, 2002b)

EMISSION FACTORS:

- PM_{10} – 0.941 Mg/hectare-month (MRI, 1996)

NOTES AND ASSUMPTIONS:

- $PM_{2.5}$ size fraction of PM_{10} is 0.20785 (ARB, 2002).
- INEGI construction permit data were unavailable for Baja California, Coahuila, Hidalgo, México, Michoacán, Nayarit, Nuevo León, Puebla, Querétaro, Quintana Roo, San Luis Potosí, Sonora, Tamaulipas, Tlaxcala, Yucatán, and Zacatecas. Permit data from the other states were extrapolated to municipalities with a population of 100,000 or greater within these 16 states without data.
- No municipality with a population of 100,000 or greater is located in the state of Tlaxcala, so there are zero emissions.
- Average areas for construction sites were assumed based on typical areas used in Mexico construction cost statistics.
- Average area for a residential construction site was assumed to be 0.01 hectares (100 m^2).
- Average area for commercial and service sector construction site was assumed to be 0.486 hectares (4,860 m^2).
- Average area for an industrial construction site was assumed to be 0.176 hectares (1,760 m^2).
- Average duration for residential construction was assumed to be 1 month.
- Average duration for all other types of construction was assumed to be 2 months.

SAMPLE CALCULATIONS:

Estimate total annual emissions from residential construction activities.

<u>State level emissions – Chihuahua</u>:

Number of permits for residential construction = 9,860
Total area of construction = 9,860 × 0.01 hectares = 98.6 hectares

PM_{10} emissions = (98.6 hectares × 0.941 Mg/hectare-month × 1 month) = 92.8 Mg
$PM_{2.5}$ emissions = 92.8 Mg × 0.20785 = 19.3 Mg

<u>Municipality Level emissions – Ciudad Juárez</u>:

Number of permits for residential construction in Ciudad Juárez = 5,125
Total area of construction = 5,125 × 0.01 hectares = 51.25 hectares

PM_{10} emissions = (51.25 hectares × 0.941 Mg/hectare-month × 1 month) = 48.2 Mg
$PM_{2.5}$ emissions = 48.2 Mg × 0.20785 = 10.0 Mg

Construction Activities								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	338.1	70.3	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	221.9	46.1	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	877.3	182.3	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	453.7	94.3	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	222.2	46.2	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	322.1	66.9	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	0.0	0.0	2,435.3	506.1	0.0
National								

Activity Data Rating: C

Emission Factor Rating: D

Overall Rating: D

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Paved Road Dust

DESCRIPTION:
Dust re-entrained by vehicle travel over paved road surfaces.

POLLUTANTS:
PM_{10} and $PM_{2.5}$

METHOD:
Emission factors

ACTIVITY DATA:
- Population (INEGI, 2000b)
- Per capita VKT rates (TransEngineering, 2004a)
- Paved and unpaved VKT split (TransEngineering, 2004b)
- Silt loading (IMIP, 2000; CIMAV, 2003)
- Average vehicle weight (CIMAV, 2003)
- Precipitation data (SMN, 2003; NCDC, 2003)

EMISSION FACTORS:
Calculated using AP-42 emission factor equation:

$$EF\ (g/VKT) = [k(sL/2)^{0.65}(W/3)^{1.5} - C] \times (1 - p/4n)$$

k = particle size multiplier (4.6 for PM_{10} and 1.1 for $PM_{2.5}$); sL = silt loading; W = average vehicle weight; C = emission factor for exhaust, brake wear, and tire wear; p = number of precipitation days during period of interest; and n = total number of days during period of interest

NOTES AND ASSUMPTIONS:
- Silt loading of 9.97 g/m^2 was assumed throughout the country based upon a 33-percentile value calculated from data collected in Ciudad Juárez and Chihuahua (IMIP, 2000; CIMAV, 2003).
- Average vehicle weight of 2.4 tons (CIMAV, 2003).
- Period of interest was the 1999 inventory year (i.e., 365 days).

SAMPLE CALCULATIONS:
Estimate the total paved road dust emissions in Baja California.

<u>Municipality Level Emissions – Mexicali</u>:
- Per capita VKT rate (5.2 VKT/day-person for municipalities 250,000-1,000,000)
- Paved VKT split (0.9655 for municipalities 250,000-1,000,000)
- 3 days recorded precipitation

Annual paved VKT = 764,602 × (5.2 VKT/person-day) × 365 days × 0.9655 = 1,401,147,692 VKT
Emission factors
$EF (PM_{10}) = [4.6(9.97/2)^{0.65}(2.4/3)^{1.5} - 0.1317] \times (1 - 3/1460) = 9.200$ g/VKT
$EF (PM_{2.5}) = [1.1(9.97/2)^{0.65}(1.5/3)^{1.5} - 0.1005] \times (1 - 3/1460) = 2.131$ g/VKT
Total PM_{10} emissions = 1,401,147,692 VKT × 9.200 g/VKT = 12,891.2 Mg
Total $PM_{2.5}$ emissions = 1,401,147,692 VKT × 2.131 g/VKT = 2,986.2 Mg

<u>State Level Emissions: Baja California</u>:
Total emissions in Baja California = Emissions (Ensenada + Mexicali + Tecate + Tijuana + Playas de Rosarito)
Total PM_{10} emissions in Baja California = 6,206.9 + 12,891.2 + 343.1 + 23,491.0 + 278.5 = 43,210.7 Mg
Total $PM_{2.5}$ emissions in Baja California = 1,437.8 + 2,986.2 + 79.5 + 5,441.6 + 64.5 = 10,009.6 Mg

Paved Road Dust								
State Code	State Name	Annual Emissions (Mg/yr)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	43,210.6	10,009.6	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	29,506.3	6,835.0	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	42,503.3	9,845.8	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	100,379.5	23,252.6	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	26,516.5	6,142.5	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	38,113.5	8,828.9	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	0.0	0.0	280,229.7	64,914.4	0.0
National								

Activity Data Rating: B Emission Factor Rating: C Overall Rating: C

Date: May 10, 2004

SOURCE TYPE: Area **SOURCE CATEGORY:** Unpaved Road Dust

DESCRIPTION:

Dust re-entrained by vehicle travel over unpaved road surfaces.

POLLUTANTS:

PM_{10} and $PM_{2.5}$

METHOD:

Emission factors

ACTIVITY DATA:

- Population (INEGI, 2000b)
- Per capita VKT rates (TransEngineering, 2004a)
- Paved and unpaved VKT split (TransEngineering, 2004b)
- Silt content (IMIP, 2000; CIMAV, 2003)
- Soil moisture (IMIP, 2000)
- Vehicle speed (TransEngineering, 2004c)
- Precipitation data (SMN, 2003; NCDC, 2003)

EMISSION FACTORS:

- Calculated using AP-42 emission factor equation:

$$EF\ (lb/VMT) = [(k(s/12)^{1.0}(S/30)^{0.5}/(M/0.5)^{0.2}) - C] \times [(365 - p)/365]$$

k = particle size multiplier (1.8 lb/VMT for PM_{10} and 0.27 lb/VMT for $PM_{2.5}$); s = silt content; S = average vehicle speed; M = moisture content; C = emission factor for exhaust, brake wear and tire wear (0.00047 lb/VMT for PM_{10} and 0.00036 lb/VMT for $PM_{2.5}$); and p = number of precipitation days during inventory year

NOTES AND ASSUMPTIONS:

- Silt content of 7.54% and moisture content of 0.26% was used throughout the country based on average of data from Ciudad Juárez and Chihuahua (IMIP, 2000; CIMAV 2003).
- Average vehicle speed was assumed to be 20.3 mph based on studies in Ciudad Juárez (TransEngineering, 2004c).

SAMPLE CALCULATIONS:

Estimate the total unpaved road dust emissions in Baja California.

Municipality Level Emissions – Mexicali:

Per capita VKT rate (5.2 VKT/day-person for municipalities with 250,000-1,000,000 population)
Unpaved VKT split (0.0345 for municipalities with 250,000-1,000,000 population)
3 days of precipitation
Unpaved VKT = 764,602 × (5.2 VKT/day) × 365 days × 0.0345 = 50,066,904 VKT

Emission factors

$EF\ (PM_{10}) = [((1.8)(7.54/12)^{1.0}(20.3/30)^{0.5}/(0.26/0.5)^{0.2}) - 0.00047] \times [(365 - 3)/365] = 1.051\ lb/VMT = 296.0\ g/VKT$

$EF\ (PM_{2.5}) = [((0.27)(7.54/12)^{1.0}(20.3/30)^{0.5}/(0.26/0.5)^{0.2}) - 0.00036] \times [(365 - 3)/365] = 0.159\ lb/VMT = 44.3\ g/VKT$

Total PM_{10} emissions in Mexicali = 50,066,904 VKT × 296.0 g/VKT = 14,819,640 kg = 14,819.6 Mg
Total $PM_{2.5}$ emissions in Mexicali = 50,066,904 VKT × 48.1 g/VKT = 2,218,897 kg = 2,218.9 Mg

State Level Emissions – Baja California:

Total emissions in Baja California = Emissions (Ensenada + Mexicali + Tecate + Tijuana + Playas de Rosarito)
Total PM_{10} emissions in Baja California = 6,983.6 + 14,819.6 + 2,165.5 + 40,021.5 + 1,733.5 = 65,723.7 Mg
Total $PM_{2.5}$ emissions in Baja California = 1,045.6 + 2,218.9 + 324.2 + 5,992.3 + 259.6 = 9,840.6 Mg

Unpaved Road Dust								
		Annual Emissions (Mg/year)						
State Code	**State Name**	**NO_x**	**SO_x**	**VOC**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	65,723.7	9,840.6	0.0
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	55,154.6	8,258.1	0.0
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	91,965.3	13,769.7	0.0
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	85,190.1	12,755.2	0.0
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	61,049.3	9,140.7	0.0
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	60,096.5	8,998.1	0.0
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	0.0	0.0	419,179.5	62,762.4	0.0
National								

Activity Data Rating: B   Emission Factor Rating: C   Overall Rating: C

Date: <u>May 10, 2004</u>

SOURCE TYPE: Area **SOURCE CATEGORY:** Domestic Ammonia

DESCRIPTION:
Various domestic ammonia emissions – pet waste (dogs and cats), human respiration and perspiration, household ammonia use, cigarette smoke, diapers (cloth and disposable), and untreated human waste.

POLLUTANTS:
NH_3

METHOD:
Per capita emission factors

ACTIVITY DATA:
- Population (INEGI, 2000b)
- Infant population (< 3 yrs) (INEGI, 2000b)
- Pet ratios (Radian, 1997)

EMISSION FACTORS:
- Dogs – 2.49 kg/head-year; cats – 0.82 kg/head-year; cigarettes – 5.2 mg/cigarette; human perspiration – 0.25 kg/person-year; human respiration – 0.0016 kg/person-year; household ammonia use – 0.023 kg/person-year; diapers (cloth) – 3.13 kg/infant-year; diapers (disposable) – 0.16 kg/infant-year; human waste (homeless) – 4.99 kg/person-year; and human waste (other) – 0.023 kg/person-year (Radian, 1997)

NOTES AND ASSUMPTIONS:
- Dog ratios (animals/1,000 people) – 122 (urban); 167 (suburban); 220 (rural) (Radian, 1997).
- Cat ratios (animals/1,000 people) – 83 (urban); 111 (suburban); 133 (rural) (Radian, 1997).
- Urban areas (>800,000 people), suburban (200,000-800,000 people), rural (<200,000).
- 15% of the population smokes, with each individual smoking 20 cigarettes every day.
- Diaper use is 55% disposable diapers and 45% cloth diapers (Richer, 2003).
- 1% of the population is homeless.

SAMPLE CALCULATIONS:
Estimate the total annual domestic ammonia emissions in Baja California.

Municipality level emissions – Mexicali:

Annual domestic ammonia emissions in Mexicali (764,602 population):
Dogs = 764,602 people × (167 dogs/1,000 people) × 2.49 kg NH_3/dog-year = 317,944 kg = 317.9 Mg
Cats = 764,602 people × (111 cats/1,000 people) × 0.82 kg NH_3/cat-year = 69,594 kg = 69.6 Mg
Cigarette smoke = 764,602 people × 0.15 × 20 cigarettes/day × 365 × 5.2 mg/cigarette = 4,354 kg = 4.4 Mg
Perspiration = 764,602 people × 0.25 kg NH_3/person-year = 191,150 kg = 191.2 Mg
Respiration = 764,602 people × 0.0016 kg NH_3/person-year = 1,223 kg = 1.2 Mg
Household ammonia use = 764,602 people × 0.023 kg NH_3/person-year = 17,586 kg = 17.6 Mg
Cloth diapers = 764,602 people × 0.0635 × 0.45 × 3.13 kg NH_3/infant-year = 68,386 kg = 68.4 Mg
Disposable diapers = 764,602 people × 0.0635 × 0.55 × 0.16 kg NH_3/infant-year = 4,273 kg = 4.3 Mg
Human waste (homeless) = 764,602 people × 0.01 × 4.99 kg NH_3/person-year = 38,154 kg = 38.2 Mg
Human waste (other) = 764,602 people × 0.99 × 0.023 kg NH_3/person-year) = 17,410 kg = 17.4 Mg

Total emissions in Mexicali = 317.9 + 69.6 + 4.4 + 191.2 + 1.2 + 17.6 + 68.4 + 4.3 + 38.2 + 17.4 = 730.1 Mg

State level emissions:

Total emissions in Baja California = Emissions (Ensenada + Mexicali + Tecate + Tijuana + Playas de Rosarito)
= 354.0 + 730.1 + 86.0 + 992.7 + 70.1 = 2,232.7 Mg

Domestic Ammonia								
State Code	State Name	Annual Emissions (Mg/year)						
		NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
01	Aguascalientes							
02	Baja California	0.0	0.0	0.0	0.0	0.0	0.0	2,232.7
03	Baja California Sur							
04	Campeche							
05	Coahuila	0.0	0.0	0.0	0.0	0.0	0.0	2,372.9
06	Colima							
07	Chiapas							
08	Chihuahua	0.0	0.0	0.0	0.0	0.0	0.0	2,924.8
09	Distrito Federal							
10	Durango							
11	Guanajuato							
12	Guerrero							
13	Hidalgo							
14	Jalísco							
15	México							
16	Michoacán							
17	Morelos							
18	Nayarit							
19	Nuevo León	0.0	0.0	0.0	0.0	0.0	0.0	3,632.8
20	Oaxaca							
21	Puebla							
22	Querétaro							
23	Quintana Roo							
24	San Luis Potosí							
25	Sinaloa							
26	Sonora	0.0	0.0	0.0	0.0	0.0	0.0	2,304.5
27	Tabasco							
28	Tamaulipas	0.0	0.0	0.0	0.0	0.0	0.0	2,785.7
29	Tlaxcala							
30	Veracruz							
31	Yucatán							
32	Zacatecas							
Border States		0.0	0.0	0.0	0.0	0.0	0.0	16,253.4
National								

Activity Data Rating: B Emission Factor Rating: D Overall Rating: D

Date: May 10, 2004

APPENDIX D

ADDITIONAL MOTOR VEHICLE DATA

Baja California: 1999 Motor Vehicle Emissions Inventory (Final)
Mg/year, by Vehicle Classification

Vehicle Classification	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Light-Duty Gasoline Vehicle (LDGV)	2,846.1	303.9	9,435.4	68,790.2	47.1	27.0	135.3
Light-Duty Gasoline Truck (LDGT)	1,831.5	268.6	5,134.9	44,979.7	37.1	22.5	92.9
Heavy-Duty Gasoline Vehicle (HDGV)	447.6	44.6	703.3	5,316.6	11.4	8.0	3.8
Light-Duty Diesel Vehicle (LDDV)	20.0	1.0	16.6	33.2	4.4	3.9	0.1
Light-Duty Diesel Truck (LDDT)	10.5	0.6	9.1	17.5	1.7	1.5	0.0
Heavy-Duty Diesel Vehicle (HDDV)	8,044.4	129.3	653.7	3,308.2	289.5	257.9	11.5
Motorcycle (MC)	38.4	3.7	100.4	610.9	1.4	0.8	0.5
Total	13,238.6	751.8	16,053.3	123,056.3	392.7	321.6	244.1

Coahuila: 1999 Motor Vehicle Emissions Inventory (Final)
Mg/year, by Vehicle Classification

Vehicle Classification	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Light-Duty Gasoline Vehicle (LDGV)	2,192.2	238.5	7,257.2	57,441.3	37.0	21.2	93.8
Light-Duty Gasoline Truck (LDGT)	1,426.1	210.8	4,018.5	37,955.2	29.1	17.6	64.4
Heavy-Duty Gasoline Vehicle (HDGV)	326.3	35.0	547.0	5,213.9	9.0	6.3	2.7
Light-Duty Diesel Vehicle (LDDV)	15.7	0.8	15.5	29.9	3.5	3.1	0.1
Light-Duty Diesel Truck (LDDT)	8.1	0.5	8.3	16.2	1.4	1.2	0.0
Heavy-Duty Diesel Vehicle (HDDV)	6,342.3	101.5	682.4	3,795.6	227.0	202.2	8.0
Motorcycle (MC)	28.1	2.9	82.0	562.6	1.1	0.6	0.3
Total	10,338.6	590.0	12,611.0	105,014.5	308.0	252.2	169.3

Chihuahua: 1999 Motor Vehicle Emissions Inventory (Final)
Mg/year, by Vehicle Classification

Vehicle Classification	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Light-Duty Gasoline Vehicle (LDGV)	3,040.7	328.5	10,132.7	79,781.1	51.0	29.2	137.2
Light-Duty Gasoline Truck (LDGT)	1,976.7	290.3	5,619.9	52,589.2	40.1	24.3	94.2
Heavy-Duty Gasoline Vehicle (HDGV)	445.0	48.2	774.2	7,462.1	12.4	8.7	3.9
Light-Duty Diesel Vehicle (LDDV)	21.7	1.0	21.7	41.8	4.8	4.3	0.1
Light-Duty Diesel Truck (LDDT)	11.2	0.7	11.7	22.6	1.9	1.7	0.0
Heavy-Duty Diesel Vehicle (HDDV)	8,785.6	139.8	967.2	5,412.7	313.0	278.8	11.7
Motorcycle (MC)	38.3	4.0	114.9	804.7	1.5	0.9	0.5
Total	14,319.1	812.6	17,642.2	146,114.3	424.5	347.7	247.6

Nuevo León: 1999 Motor Vehicle Emissions Inventory (Final)
Mg/year, by Vehicle Classification

Vehicle Classification	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Light-Duty Gasoline Vehicle (LDGV)	7,881.3	786.3	27,605.8	196,434.0	122.0	70.0	311.9
Light-Duty Gasoline Truck (LDGT)	5,047.1	695.4	15,211.5	125,197.3	96.0	58.1	214.1
Heavy-Duty Gasoline Vehicle (HDGV)	1,097.4	115.5	2,255.3	19,240.6	29.6	20.8	8.8
Light-Duty Diesel Vehicle (LDDV)	56.1	2.5	48.5	98.8	11.4	10.2	0.2
Light-Duty Diesel Truck (LDDT)	29.4	1.6	26.2	51.5	4.5	4.0	0.1
Heavy-Duty Diesel Vehicle (HDDV)	22,399.4	334.8	2,139.1	11,772.3	749.1	667.2	26.6
Motorcycle (MC)	94.4	9.6	303.1	2,275.7	3.6	2.1	1.1
Total	36,605.1	1,945.6	47,589.3	355,070.0	1,016.1	832.3	562.8

Sonora: 1999 Motor Vehicle Emissions Inventory (Final)
Mg/year, by Vehicle Classification

Vehicle Classification	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Light-Duty Gasoline Vehicle (LDGV)	1,700.0	182.8	5,621.2	41,113.4	28.4	16.3	85.1
Light-Duty Gasoline Truck (LDGT)	1,094.7	161.6	3,057.2	26,943.2	22.3	13.5	58.4
Heavy-Duty Gasoline Vehicle (HDGV)	269.3	26.8	415.5	3,123.2	6.9	4.8	2.4
Light-Duty Diesel Vehicle (LDDV)	11.9	0.6	9.9	19.8	2.7	2.4	0.1
Light-Duty Diesel Truck (LDDT)	6.3	0.4	5.4	10.5	1.0	0.9	0.0
Heavy-Duty Diesel Vehicle (HDDV)	4,800.2	77.8	390.2	1,964.3	174.1	155.1	7.3
Motorcycle (MC)	23.1	2.2	59.8	358.4	0.8	0.5	0.3
Total	7,905.5	452.2	9,559.4	73,532.7	236.2	193.5	153.6

Tamaulipas: 1999 Motor Vehicle Emissions Inventory (Final)
Mg/year, by Vehicle Classification

Vehicle Classification	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Light-Duty Gasoline Vehicle (LDGV)	2,629.0	282.4	8,663.4	63,617.7	43.8	25.1	121.6
Light-Duty Gasoline Truck (LDGT)	1,693.8	249.6	4,708.7	41,700.4	34.4	20.9	83.5
Heavy-Duty Gasoline Vehicle (HDGV)	419.9	41.5	637.7	4,759.5	10.6	7.5	3.4
Light-Duty Diesel Vehicle (LDDV)	18.6	0.9	15.2	30.4	4.1	3.7	0.1
Light-Duty Diesel Truck (LDDT)	9.7	0.6	8.3	16.1	1.6	1.4	0.0
Heavy-Duty Diesel Vehicle (HDDV)	7,464.6	120.2	589.0	2,963.8	268.8	239.4	10.4
Motorcycle (MC)	36.1	3.5	91.9	545.8	1.3	0.8	0.4
Total	12,271.7	698.5	14,714.2	113,633.7	364.6	298.7	219.4

APPENDIX E

ADDITIONAL NONROAD MOBILE SOURCE DATA

Baja California: 1999 Nonroad Mobile Source Emissions Inventory (Final)
Mg/year, by Equipment Classification

Equipment Types	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Construction Equipment	3,873.6	538.0	1,351.3	4,570.4	528.5	486.2
Agricultural Equipment	1,156.0	146.0	195.0	778.0	216.0	199.0
Total	5,029.6	684.0	1,546.3	5,348.4	744.5	685.2

Coahuila: 1999 Nonroad Mobile Source Emissions Inventory (Final)
Mg/year, by Equipment Classification

Equipment Types	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Construction Equipment	3,585.8	498.2	1,237.8	4,258.4	489.3	450.2
Agricultural Equipment	1,198.0	157.0	200.0	796.0	225.0	207.0
Total	4,783.8	655.2	1,437.8	5,054.4	714.3	657.2

Chihuahua: 1999 Nonroad Mobile Source Emissions Inventory (Final)
Mg/year, by Equipment Classification

Equipment Types	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Construction Equipment	3,738.1	519.3	1,304.0	4,410.5	510.1	469.3
Agricultural Equipment	7,533.0	971.0	1,262.0	5,059.0	1,410.0	1,297.0
Total	11,271.1	1,490.3	2,566.0	9,469.5	1,920.1	1,766.3

Nuevo León: 1999 Nonroad Mobile Source Emissions Inventory (Final)
Mg/year, by Equipment Classification

Equipment Types	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Construction Equipment	7,259.8	1,008.6	2,503.1	8,627.8	990.7	911.5
Agricultural Equipment	943.0	120.0	157.0	630.0	176.0	162.0
Total	8,202.8	1,128.6	2,660.1	9,257.8	1,166.7	1,073.5

Sonora: 1999 Nonroad Mobile Source Emissions Inventory (Final)
Mg/year, by Equipment Classification

Equipment Types	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Construction Equipment	4,263.8	592.3	1,482.2	5,041.7	581.9	535.3
Agricultural Equipment	3,085.0	391.0	516.0	2,067.0	576.0	530.0
Total	7,348.8	983.3	1,998.2	7,108.7	1,157.9	1,065.3

Tamaulipas: 1999 Nonroad Mobile Source Emissions Inventory (Final)
Mg/year, by Equipment Classification

Equipment Types	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Construction Equipment	5,693.7	791.1	1,960.9	6,771.6	777.1	714.9
Agricultural Equipment	8,990.0	1,118.0	1,505.0	6,056.0	1,676.0	1,542.0
Total	14,683.7	1,909.1	3,465.9	12,827.6	2,453.1	2,256.9

APPENDIX F

ADDITIONAL NATURAL SOURCE DATA

Baja California: 1999 Natural Source Emissions Inventory (Final)
Mg/year, by Category

Category	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Vegetative VOC			18,644.6			
Soil NO_x	4,452.8					
Total	**4,452.8**		**18,644.6**			

Coahuila: 1999 Natural Source Emissions Inventory (Final)
Mg/year, by Category

Category	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Vegetative VOC			376,073.7			
Soil NO_x	62,081.1					
Total	**62,081.1**		**376,073.7**			

Chihuahua: 1999 Natural Source Emissions Inventory (Final)
Mg/year, by Category

Category	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Vegetative VOC			1,926,593.9			
Soil NO_x	51,705.5					
Total	**51,705.5**		**1,926,593.9**			

Nuevo León: 1999 Natural Source Emissions Inventory (Final)
Mg/year, by Category

Category	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Vegetative VOC			265,494.1			
Soil NO_x	39,016.4					
Total	**39,016.4**		**265,494.1**			

Sonora: 1999 Natural Source Emissions Inventory (Final)
Mg/year, by Category

Category	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Vegetative VOC			788,088.4			
Soil NO_x	56,601.9					
Total	**56,601.9**		**788,088.4**			

Tamaulipas: 1999 Natural Source Emissions Inventory (Final)
Mg/year, by Category

Category	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Vegetative VOC			466,344.3			
Soil NO_x	79,399.9					
Total	**79,399.9**		**466,344.3**			

Table F-1. Planted Agricultural Acreage – Baja California (SAGARPA, 2002)

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km^2)
Wheat (Grain)	66,601	666.01
Cotton	35,310	353.10
Green Alfalfa	22,836	228.36
Barley (Grain)	14,442	144.42
Red Tomato (Jitomate)	9,611	96.11
Sorghum (Forage)	7,143	71.43
Sorghum (Grain)	6,797	67.97
Onion (bulbs)	6,451	64.51
Rye Grass	5,511	55.11
Grape (Industrial)	5,080	50.80
Carthumus	5,040	50.40
Olive	3,825	38.25
Onion	2,309	23.09
Asparagus	2,164	21.64
Corn (Grain)	2,156	21.56
Hay (Bermuda)	1,993	19.93
Various	1,742	17.42
Cucumber	1,665	16.65
Oats (Forage)	1,416	14.16
Lettuce	1,394	13.94
Corn (Forage)	1,139	11.39
Hay (Bermuda seed)	1,134	11.34
Radish	1,047	10.47
Barley (Forage)	1,034	10.34
Cilantro	888	8.88
Broccoli	794	7.94
Celery	706	7.06
Garlic	660	6.60
Squash	645	6.45
Watermelon	635	6.35
Strawberry	634	6.34
Green Tomato	615	6.15
Orange	517	5.17
Beans	491	4.91
Pea	442	4.42
Green Chili	415	4.15
Melon	385	3.85
Nopal	371	3.71
Pasture	350	3.50
Flowers	316	3.16
Potato	299	2.99
Grape (raisin)	296	2.96
Sour Lemon	296	2.96
Grape (fruit)	285	2.85

Table F-1. Cont.

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km)
Artichoke	278	2.78
Carrot	278	2.78
Cabbage	271	2.71
Sorghum (Escobero)	240	2.40
Watermelon (Seed)	240	2.40
Black Olive	230	2.30
Leek	204	2.04
Flowers (Seed)	187	1.87
Red Tomato (Seed)	159	1.59
Brussels cabbage	157	1.57
Wheat (Forage)	150	1.50
Beetroot	134	1.34
String Bean	123	1.23
Spinach	123	1.23
Squash (Seed)	116	1.16
Melon (seed)	102	1.02
Eucaliptus	96	0.96
Date	95	0.95
Green Lima Bean	91	0.91
Unknown	85	0.85
Chili (seed)	78	0.78
Apple	74	0.74
Turnip	71	0.71
Carob Tree	70	0.70
Parsley	68	0.68
Cauliflower	68	0.68
Chinese White Radish	55	0.55
Unknown	45	0.45
Avocado	41	0.41
Cucumber (Seed)	37	0.37
Peach	36	0.36
Kohlrabi	35	0.35
Mustard	33	0.33
Cherry Tomato	31	0.31
Mandarine orange	31	0.31
Broccoli (seed)	30	0.30
Nut (Shell)	28	0.28
Chard (type of beet)	28	0.28
Various Fruit Trees	25	0.25
Grapefruit (Pomelo)	25	0.25
Cauliflower (Seed)	25	0.25
Potato (seed)	24	0.24
Plum (of Almond)	24	0.24
Avocado	24	0.24
Kale	24	0.24

Table F-1. Cont.

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km)
Gladiola	22	0.22
Corn on the Cob	22	0.22
Nectarine	20	0.20
Palm (Plant)	18	0.18
Fig	16	0.16
Oats (Grain)	16	0.16
Flower Wax	15	0.15
Nap	15	0.15
Celery (Seed)	15	0.15
Purslane	14	0.14
Jojoba	13	0.13
Flower (Kale)	11	0.11
Quince	9	0.09
Chayote squash	9	0.09
Almond	8	0.08
Apricot	8	0.08
Citrus	7	0.07
Basil	6	0.06
Clover	5	0.05
Sunflower	4	0.04
Pear	3	0.03
Pistachio	3	0.03
Thyme	2	0.02
Eggplant (Seed)	2	0.02
Sage	1	0.01
Bok choy	1	0.01
Eggplant	1	0.01
Pumpkin	1	0.01
Total	**222,532**	**2,225.32**

Table F-2. Planted Agricultural Acreage – Coahuila (SAGARPA, 2002)

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km^2)
Hay (Buffel)	73,089	730.89
Corn (Grain)	43,125	431.25
Sorghum (Forage)	23,450	234.50
Green Alfalfa	22,143	221.43
Oats (Forage)	15,321	153.21
Wheat (Grain)	13,010	130.10
Beans	11,499	114.99
Pasture	10,996	109.96
Nut (Shell)	10,946	109.46
Sorghum (Grain)	8,972	89.72
Apple	7,933	79.33
Corn (Forage)	7,451	74.51
Sorghum (Escobero)	7,034	70.34
Cotton	4,823	48.23
Melon	4,423	44.23
Hay (Bermuda)	2,962	29.62
Hay	2,606	26.06
Watermelon	1,859	18.59
Carthumus	1,839	18.39
Pasture (Evergreen)	1,297	12.97
Grape (fruit)	1,199	11.99
Potato	1,197	11.97
Hay (Ballico)	1,184	11.84
Wheat (Forage)	1,131	11.31
Rye Grass	1,077	10.77
Barley (Forage)	740	7.40
Green Chili	584	5.84
Red Tomato (Jitomate)	553	5.53
Potato (seed)	441	4.41
Barley (Grain)	362	3.62
Onion	343	3.43
Various Fruit Trees	269	2.69
Carrot	252	2.52
Peach	168	1.68
Birdseed	147	1.47
Corn on the Cob	116	1.16
Oats (Grain)	96	0.96
Asparagus	90	0.90
Pistachio	81	0.81
Pumpkin	77	0.77
Cabbage	72	0.72
Squash	66	0.66
Unknown	62	0.62
Plum (from the Country)	53	0.53
Clover	49	0.49

Table F-2. Cont.

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km)
Cilantro	46	0.46
Date	39	0.39
Broccoli	38	0.38
Triticale (Grain)	35	0.35
Cauliflower	25	0.25
Rye (Forage)	24	0.24
Green Tomato	23	0.23
Nopal (Forage)	20	0.20
Lettuce	18	0.18
Triticale (Forage)	18	0.18
Avocado	15	0.15
Garlic	13	0.13
Chili (Jalapeño)	13	0.13
Parsley	11	0.11
Chili (Red Pepper)	11	0.11
Birdseed (Forage)	9	0.09
Pomegranate (Red)	8	0.08
Vegetables	8	0.08
Sunflower	7	0.07
Chard	7	0.07
Plum (of Almond)	6	0.06
Onion (bulbs)	6	0.06
Chili (Dried)	5	0.05
Radish	5	0.05
Quince	3	0.03
Apricot	3	0.03
Beetroot	3	0.03
Pear	2	0.02
Flowers	2	0.02
Total	**285,608**	**2,856.08**

Table F-3. Planted Agricultural Acreage – Chihuahua (SAGARPA, 2002)

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km^2)
Beans	195,193	1,951.93
Corn (Grain)	191,802	1,918.02
Oats (Forage)	170,770	1,707.70
Oats (Grain)	82,881	828.81
Corn (Forage)	60,411	604.11
Alfalfa	46,570	465.70
Cotton	33,013	330.13
Nut (Shell)	26,501	265.01
Apple	24,974	249.74
Green Chili	16,856	168.56
Sorghum (Grain)	13,861	138.61
Sorghum (Forage)	11,098	110.98
Wheat (Grain)	9,970	99.70
Potato	8,319	83.19
Avocado	8,272	82.72
Barley (Grain)	7,901	79.01
Oats	7,446	74.46
Onion	5,859	58.59
Pasture	5,669	56.69
Watermelon	2,993	29.93
Chili (Dried)	2,948	29.48
Rye Grass	2,915	29.15
Red Tomato (Jitomate)	1,555	15.55
Melon	1,454	14.54
Peach	1,142	11.42
Wheat (Forage)	776	7.76
Hay	657	6.57
Vegetables	454	4.54
Quince	333	3.33
Hay (Ballico)	281	2.81
Sorghum (Escobero)	232	2.32
Yam	229	2.29
Cucumber	201	2.01
Green Tomato	200	2.00
Pear	180	1.80
Grape (Industrial)	162	1.62
Garlic	130	1.30
Soybean	127	1.27
Cabbage	118	1.18
Squash	112	1.12
Pumpkin	92	0.92
Rye (Forage)	91	0.91
Triticale (Forage)	79	0.79
Various	72	0.72
Plum (from the Country)	70	0.70

Table F-3. Cont.

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km)
Corn on the Cob	65	0.65
Asparagus	50	0.50
Lettuce	41	0.41
Various Fruit Trees	40	0.40
Nopal (Forage)	27	0.27
Cherry	21	0.21
raspberry	20	0.20
Cauliflower	14	0.14
Lima Bean (grain)	10	0.10
Barley (Forage)	10	0.10
Chrysanthemum	5	0.05
Forages	5	0.05
Mint	4	0.04
Carrot	4	0.04
Chard	3	0.03
Beetroot	2	0.02
Nopal	1	0.01
Broccoli	1	0.01
Total	**945,292**	**9,452.92**

Table F-4. Planted Agricultural Acreage – Nuevo León (SAGARPA, 2002)

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km^2)
Pasture	129,374	1,293.74
Corn (Forage)	57,721	577.21
Wheat (Grain)	36,058	360.58
Sorghum (Grain)	35,490	354.90
Corn (Grain)	31,742	317.42
Orange	24,035	240.35
Sorghum (Forage)	19,079	190.79
Carthumus	10,762	107.62
Beans	5,624	56.24
Nut (Shell)	4,116	41.16
Potato	3,940	39.40
Mandarine orange	3,770	37.70
Oats (Forage)	2,767	27.67
Alfalfa	2,436	24.36
Apple	2,343	23.43
Sorghum (Escobero)	2,023	20.23
Grapefruit (Pomelo)	1,359	13.59
Peach	1,150	11.50
Barley (Forage)	1,148	11.48
Avocado	751	7.51
Barley (Grain)	670	6.70
Carrot	515	5.15
Green Chili	367	3.67
Red Tomato (Jitomate)	314	3.14
Melon	250	2.50
Watermelon	238	2.38
Cabbage	203	2.03
Avocado	186	1.86
Rye Grass	176	1.76
Asparagus	176	1.76
Cucumber	159	1.59
Squash	140	1.40
Green Tomato	105	1.05
Plum (of Almond)	97	0.97
Pear	59	0.59
Okra (Maize)	58	0.58
Hay	56	0.56
Broccoli	30	0.30
Lettuce	30	0.30
Cilantro	24	0.24
Cauliflower	16	0.16
Pumpkin	14	0.14
Sour Lemon	12	0.12
Garlic	10	0.10
Sugarcane	10	0.10

Table F-4. Cont.

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km)
White Garbanzo	6	0.06
Flowers	2	0.02
Onion	2	0.02
Apricot	1	0.01
Chili (Red Pepper)	1	0.01
Total	**379,613**	**3,796.13**

Table F-5. Planted Agricultural Acreage – Sonora (SAGARPA, 2002)

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km^2)
Wheat (Grain)	203,476	2,034.76
Carthumus	65,956	659.56
Corn (Grain)	62,008	620.08
Cotton	37,631	376.31
Sorghum (Grain)	19,980	199.80
Alfalfa	17,421	174.21
Sorghum (Forage)	13,492	134.92
Grape (fruit)	12,056	120.56
Sesame seeds	10,698	106.98
Beans	10,357	103.57
Grape (Industrial)	9,991	99.91
Orange	8,998	89.98
Rye Grass	7,431	74.31
White Garbanzo	7,301	73.01
Watermelon	7,078	70.78
Asparagus	6,689	66.89
Grape (raisin)	6,100	61.00
Green Chili	6,083	60.83
Potato	5,390	53.90
Barley	4,777	47.77
Melon	4,287	42.87
Green Tomato	3,293	32.93
Nut (Shell)	2,891	28.91
Olive	2,687	26.87
Various	2,321	23.21
Oats	2,287	22.87
Onion (bulbs)	2,080	20.80
Pumpkin	1,840	18.40
Squash	1,731	17.31
Corn (Forage)	1,607	16.07
Avocado	1,516	15.16
Red Tomato (Jitomate)	1,470	14.70
Pumpkin (Japanese Kabocha)	1,347	13.47
Corn on the Cob	1,310	13.10
Onion	1,246	12.46
Barley (Grain)	1,180	11.80
Hay (Buffel)	1,089	10.89
Broccoli	1,042	10.42
Vegetables	1,020	10.20
Cucumber	953	9.53
Hay (Bermuda)	952	9.52
Red Tomato (Salad)	728	7.28
Garlic	660	6.60
Pea	581	5.81
Wheat (Forage)	462	4.62

Table F-5. Cont.

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km)
Apple	446	4.46
Lettuce	408	4.08
Grapefruit (Pomelo)	377	3.77
Hay	338	3.38
Mango	330	3.30
Jojoba	310	3.10
Oats (Forage)	217	2.17
Date	211	2.11
Barley (Forage)	200	2.00
Unknown	197	1.97
Hay (Marigold)	194	1.94
Apricot	184	1.84
Peach	182	1.82
Leek	178	1.78
Cabbage	169	1.69
Turnip	165	1.65
Chili (Jalapeño)	154	1.54
String Bean	151	1.51
Cilantro	129	1.29
Celery	129	1.29
Fig	105	1.05
Sorghum (Escobero)	100	1.00
Lemon (Persa)	100	1.00
Radish	86	0.86
Quince	75	0.75
Carrot	70	0.70
Almond	54	0.54
Flowers	47	0.47
Soybean	44	0.44
Unknown	44	0.44
Persimmon	44	0.44
Sunflower	40	0.40
Sour Lemon	39	0.39
Brussels cabbage	39	0.39
Artichoke	36	0.36
Pasture (Evergreen)	27	0.27
Pomegranate (Red)	27	0.27
Plum (of Almond)	25	0.25
Tuna	21	0.21
Cherry	20	0.20
Papaya	20	0.20
Avocado	20	0.20
Cauliflower	19	0.19
Parsley	18	0.18
Mandarine orange	16	0.16
Chard	6	0.06

Table F-5. Cont.

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km)
Pear	3	0.03
Various Fruit Trees	3	0.03
Citrus	3	0.03
Beetroot	2	0.02
Spinach	2	0.02
Total	**569,317**	**5,693.17**

Table F-6. Planted Agricultural Acreage – Tamaulipas (SAGARPA, 2002)

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km^2)
Sorghum (Grain)	1,099,489	10,994.89
Corn (Grain)	169,672	1,696.72
Soybean	58,005	580.05
Carthumus	53,461	534.61
Sugarcane	50,220	502.20
Orange	28,766	287.66
Pasture	26,643	266.43
Cotton	17,794	177.94
Beans	15,176	151.76
Unknown	14,675	146.75
Wheat (Grain)	10,151	101.51
Onion	7,138	71.38
Okra (Maize)	3,663	36.63
Sorghum (Forage)	3,618	36.18
Unknown	2,078	20.78
Sour Lemon	1,999	19.99
Green Chili	1,974	19.74
Unknown	1,454	14.54
Sunflower	1,175	11.75
Watermelon	1,151	11.51
Red Tomato (Jitomate)	1,083	10.83
Mango	1,075	10.75
Rice	1,074	10.74
Melon	996	9.96
Grapefruit (Pomelo)	765	7.65
Corn	618	6.18
Barley (Grain)	545	5.45
Chili (Jalapeño)	487	4.87
Sorghum (Escobero)	460	4.60
String Bean	454	4.54
Nopal	378	3.78
Cucumber	361	3.61
Pumpkin (Seed)	260	2.60
Tuna	228	2.28
Various	223	2.23
Squash	212	2.12
Papaya	195	1.95
Hay (Buffel)	188	1.88
Avocado	176	1.76
Nut (De Castilla)	172	1.72
Plant fiber	160	1.60
Avocado	131	1.31
Green Tomato	120	1.20
Oats (Forage)	103	1.03
Mandarin orange	103	1.03

Table F-6. Cont.

Crop Name (English)	Hectares Planted (ha)	Square Kilometers Planted (km)
Hay (Bermuda)	96	0.96
Cabbage	77	0.77
Red Tomato (Salad)	76	0.76
Sesame seeds	60	0.60
Agave (tequila plant)	56	0.56
Rye Grass	49	0.49
Beetroot	37	0.37
Pumpkin	35	0.35
White Garbanzo	26	0.26
Turnip (Forage)	26	0.26
Lime	24	0.24
Unknown	20	0.20
Carrot	20	0.20
Celery	20	0.20
Organic Garlic	18	0.18
Cilantro	16	0.16
Alfalfa	14	0.14
Chard (type of beet)	11	0.11
Chili (Dried)	10	0.10
Tamarind	8	0.08
Corn (Forage)	7	0.07
Pineapple	6	0.06
Lettuce	5	0.05
Chili (Poblano)	4	0.04
Eggplant	4	0.04
Apple	3	0.03
Garlic	2	0.02
Potato	2	0.02
Banana	2	0.02
Unknown	2	0.02
Cauliflower	2	0.02
Chili (Red Pepper)	2	0.02
Pea	2	0.02
Total	**1,579,611**	**15,796.11**

Table F-7. Crop Type to GloBEIS Emission Factor Cross Reference List

Crop Name	Crop Name (English)	vegib2 Code	lcVeg Code	lc Code	Description
Aceituna	Olive	Mscp	Mscp	99108	Miscellaneous Crops
Aceituna Negra	Black Olive	Mscp	Mscp	99108	Miscellaneous Crops
Acelga	Chard (type of beet)	Mscp	Mscp	99108	Miscellaneous Crops
Agave Tequilero	agave (tequila plant)	Othe	Agalec		Agave
Aguacate	Avocado	Mscp	Mscp	99108	Miscellaneous Crops
Ajo	Garlic	Mscp	Mscp	99108	Miscellaneous Crops
Ajo (Organico)	Organic Garlic	Mscp	Mscp	99108	Miscellaneous Crops
Ajonjoli	Sesame seeds	Mscp	Mscp	99108	Miscellaneous Crops
Albahaca	Basil	Mscp	Mscp	99108	Miscellaneous Crops
Alcachofa	Artichoke	Mscp	Mscp	99108	Miscellaneous Crops
Alfalfa Achicalada	Alfalfa	Alfalfa	Alfalfa	99103	Alfalfa
Alfalfa Verde	Green Alfalfa	Alfalfa	Alfalfa	99103	Alfalfa
Algarrobo	Carob Tree	Pean	Pean-B2	99112	Peanut
Algodon Hueso	Cotton	Cott	Cotton	99028	Cotton
Almendra	Almond	Prun	Prusp	99064	Cherry
Alpiste	Birdseed	Mscp	Mscp	99108	Miscellaneous Crops
Alpiste Forrajero	Birdseed (Forage)	Mscp	Mscp	99108	Miscellaneous Crops
Apio	Celery	Mscp	Mscp	99108	Miscellaneous Crops
Apio (Semilla)	Celery (Seed)	Mscp	Mscp	99108	Miscellaneous Crops
Arroz Palay	Rice	Rice	Rice	99114	Rice
Avena Achicalada	Oats	Oats	Oats	99109	Oats
Avena Forrajera	Oats (Forage)	Oats	Oats	99109	Oats
Avena Grano	Oats (Grain)	Oats	Oats	99109	Oats
Berenjena	Eggplant	Mscp	Mscp	99108	Miscellaneous Crops
Berenjena (Semilla)	Eggplant (Seed)	Mscp	Mscp	99108	Miscellaneous Crops
Betabel	Beetroot	Mscp	Mscp	99108	Miscellaneous Crops
Boi Choi	Bok choy	Mscp	Mscp	99108	Miscellaneous Crops
Brocoli	Broccoli	Mscp	Mscp	99108	Miscellaneous Crops
Brocoli (Semilla)	Broccoli (seed)	Mscp	Mscp	99108	Miscellaneous Crops
Cacahuate	Avocado	Mscp	Mscp	99108	Miscellaneous Crops
Calabacita	Squash	Mscp	Mscp	99108	Miscellaneous Crops
Calabacita (Semilla)	Squash (Seed)	Mscp	Mscp	99108	Miscellaneous Crops
Calabaza	Pumpkin	Mscp	Mscp	99108	Miscellaneous Crops
Calabaza (Semilla) Chihua	Pumpkin (Seed)	Mscp	Mscp	99108	Miscellaneous Crops
Calabaza Kabocha	Pumpkin (Japanese Kabocha)	Mscp	Mscp	99108	Miscellaneous Crops
Camote	Yam	Mscp	Mscp	99108	Miscellaneous Crops
Caña De Azucar	Sugarcane	Mscp	Sugcan		Sugarcane
Caña De Azucar (Piloncillo)	Sugarcane	Mscp	Sugcan		Sugarcane
Cartamo	Carthumus	Mscp	Mscp	99108	Miscellaneous Crops

Table 7-1. Cont.

Crop Name	Crop Name (English)	vegib2 Code	lcVeg Code	lc Code	Description
Cebada Achicalada	Barley	Barley	Barley	99015	Barley
Cebada Forrajera	Barley (Forage)	Barley	Barley	99015	Barley
Cebada Grano	Barley (Grain)	Barley	Barley	99015	Barley
Cebolla	Onion	Mscp	Mscp	99108	Miscellaneous Crops
Cebollin	Onion (bulbs)	Mscp	Mscp	99108	Miscellaneous Crops
Centeno Forrajero	Rye (Forage)	Rye	Rye	99115	Rye
Cereza	Cherry	Prun	Prusp	99064	Cherry
Chabacano	Apricot	Prun	Prusp	99064	Cherry
Chayote	Chayote squash	Mscp	Mscp	99108	Miscellaneous Crops
Chicharo	Pea	Mscp	Mscp	99108	Miscellaneous Crops
Chile (Semilla)	Chili (seed)	Toba	Toba	99120	Tobacco
Chile Jalapeño	Chili (Jalapeño)	Toba	Toba	99120	Tobacco
Chile Morron	Chili (Red Pepper)	Toba	Toba	99120	Tobacco
Chile Poblano	Chili (Poblano)	Toba	Toba	99120	Tobacco
Chile Seco	Chili (Dried)	Toba	Toba	99120	Tobacco
Chile Verde	Green Chili	Toba	Toba	99120	Tobacco
Cilantro	Cilantro	Mscp	Mscp	99108	Miscellaneous Crops
Ciruela De Almendra	Plum (of Almond)	Prun	Prucer	99064	Cherry Plum
Ciruela Del Pais	Plum (from the Country)	Prun	Prucer	99064	Cherry Plum
Citricos	Citrus	Citr	Citr-B2	98027	Citrus
Clyptoria	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Col (Repollo)	Cabbage	Mscp	Mscp	99108	Miscellaneous Crops
Col De Bruselas	Brussels cabbage	Mscp	Mscp	99108	Miscellaneous Crops
Coliflor	Cauliflower	Mscp	Mscp	99108	Miscellaneous Crops
Coliflor (Semilla)	Cauliflower (Seed)	Mscp	Mscp	99108	Miscellaneous Crops
Crisantemo	Chrysenthemum	Mscp	Mscp	99108	Miscellaneous Crops
Daikon	Chinese White Radish	Mscp	Mscp	99108	Miscellaneous Crops
Damazco	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Datil	Date	Mscp	Mscp	99108	Miscellaneous Crops
Durazno	Peach	Prun	Pruper	99064	Flowering Peach
Ejote	String Bean	Pean	Pean-B2	99112	Peanut
Elote	Corn on the Cob	Corn	Corn	99027	Corn
Esparrago	Asparagus	Mscp	Mscp	99108	Miscellaneous Crops
Especias Y Medicinales	Spices and Medicinal	Mscp	Mscp	99108	Miscellaneous Crops
Espinaca	Spinach	Mscp	Mscp	99108	Miscellaneous Crops
Eucalipto	Eucalyptus	Euca	Eucsp	99105	Eucalyptus
Flor Cera	Flower Wax	Mscp	Mscp	99108	Miscellaneous Crops
Flor Kale	Flower (Kale)	Mscp	Mscp	99108	Miscellaneous Crops
Flores	Flowers	Mscp	Mscp	99108	Miscellaneous Crops
Flores (Semilla)	Flowers (Seed)	Mscp	Mscp	99108	Miscellaneous Crops
Forrajes	Forages	Grass	Grass	98043	Grass

Table 7-1. Cont.

Crop Name	Crop Name (English)	vegib2 Code	lcVeg Code	lc Code	Description
Frambuesa	raspberry	Mscp	Mscp	99108	Miscellaneous Crops
Fresa	Strawberry	Mscp	Mscp	99108	Miscellaneous Crops
Frijol	Beans	Pean	Pean-B2	99112	Peanut
Frutales Varios	Various Fruit Trees	Mscp	Mscp	99108	Miscellaneous Crops
Gailan	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Garbanzo Blanco	White Garbanzo	Pean	Pean-B2	99112	Peanut
Girasol	Sunflower	Othe	Sunflower		Sunflower
Gladiola	Gladiola	Mscp	Mscp	99108	Miscellaneous Crops
Granada Roja	Pomegranate (Red)	Mscp	Mscp	99108	Miscellaneous Crops
Haba Grano	Lima Bean (grain)	Pean	Pean-B2	99112	Peanut
Haba Verde	Green Lima Bean	Pean	Pean-B2	99112	Peanut
Henequen Verde	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Higo	Fig	Othe	Ficcar		Fig
Hortalizas	Vegetables	Mscp	Mscp	99108	Miscellaneous Crops
Jamaica	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Jojoba	Jojoba	Mscp	Mscp	99108	Miscellaneous Crops
Kale	Kale	Mscp	Mscp	99108	Miscellaneous Crops
Kenaf	Plant fiber	Mscp	Mscp	99108	Miscellaneous Crops
Kohlrabi	Kohlrabi	Mscp	Mscp	99108	Miscellaneous Crops
Lechuga	Lettuce	Mscp	Mscp	99108	Miscellaneous Crops
Lechuga (Organica)	Lettuce (Organic)	Mscp	Mscp	99108	Miscellaneous Crops
Leek	Leek	Mscp	Mscp	99108	Miscellaneous Crops
Lima	Lime	Citr	Citr-B2	98027	Citrus
Limon Agrio	Sour Lemon	Citr	Citr-B2	98027	Citrus
Limon Persa	Lemon (Persa)	Citr	Citr-B2	98027	Citrus
Maiz Forrajero	Corn (Forage)	Corn	Corn	99027	Corn
Maiz Grano	Corn (Grain)	Corn	Corn	99027	Corn
Maiz Palomero	Corn	Corn	Corn	99027	Corn
Mandarina	Mandarine orange	Citr	Citr-B2	98027	Citrus
Mango	Mango	Mscp	Mscp	99108	Miscellaneous Crops
Manzana	Apple	Malu	malsp	98057	Apple
Melon	Melon	Mscp	Mscp	99108	Miscellaneous Crops
Melon (Semilla)	Melon (seed)	Mscp	Mscp	99108	Miscellaneous Crops
Membrillo	Quince	Mscp	Mscp	99108	Miscellaneous Crops
Menta	Mint	Mscp	Mscp	99108	Miscellaneous Crops
Mostaza	Mustard	Mscp	Mscp	99108	Miscellaneous Crops
Nabo Forrajero	Turnip (Forage)	Mscp	Mscp	99108	Miscellaneous Crops
Nanche	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Napa	Nap	Mscp	Mscp	99108	Miscellaneous Crops
Naranja	Orange	Citr	Citsp	98027	Orange Tree
Nectarina	Nectarine	Citr	Citr-B2	98027	Citrus
Nopal Forrajero	Nopal (Forage)	Grass	Grass	98043	Grass
Nopalitos	Nopal	Mscp	Mscp	99108	Miscellaneous Crops
Nuez De Castilla	Nut (De Castilla)	Pean	Pean-B2	99112	Peanut

Table 7-1. Cont.

Crop Name	Crop Name (English)	vegib2 Code	lcVeg Code	lc Code	Description
Nuez Encarcelada	Nut (Shell)	Pean	Pean-B2	99112	Peanut
Okra (Angu O Gombo)	Okra (Maize)	Mscp	Mscp	99108	Miscellaneous Crops
Palma De Ornato (Plantas)	Palm (Plant)	Othe	Cycrev	98120	Palm
Papa	Potato	Pota	Pota	99113	Potato
Papa (Semilla)	Potato (seed)	Pota	Pota	99113	Potato
Papaya	Papaya	Mscp	Mscp	99108	Miscellaneous Crops
Pasto	Pasture	Past	Past	99111	Pasture
Pasto Ever Green	Pasture (Evergreen)	Past	Past	99111	Pasture
Pepino	Cucumber	Mscp	Mscp	99108	Miscellaneous Crops
Pepino (Semilla)	Cucumber (Seed)	Mscp	Mscp	99108	Miscellaneous Crops
Pera	Pear	Othe	Pyrang		Pear
Perejil	Parsley	Mscp	Mscp	99108	Miscellaneous Crops
Persimonio	Persimmon	Dios	Diotex	98037	Persimmon
Piña	Pineapple	Mscp	Mscp	99108	Miscellaneous Crops
Pistache	Pistachio	othe	Pischi		Pistachio
Platano	Banana	Othe	Micfig		Banana
Poro	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Quelite	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Rabanito	Radish	Mscp	Mscp	99108	Miscellaneous Crops
Rabano	Radish	Mscp	Mscp	99108	Miscellaneous Crops
Rapini	Turnip	Mscp	Mscp	99108	Miscellaneous Crops
Rye Grass	Rye Grass	Rye	Rye	99115	Rye
Sabila	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Salvia	Sage	Mscp	Mscp	99108	Miscellaneous Crops
Sandia	Watermelon	Mscp	Mscp	99108	Miscellaneous Crops
Sandia (Semilla)	Watermelon (Seed)	Mscp	Mscp	99108	Miscellaneous Crops
Shop Suey	unknown	Mscp	Mscp	99108	Miscellaneous Crops
Sorgo Escobero	Sorghum (Escobero)	Sorg	Sorghum	99118	Sorghum
Sorgo Forrajero	Sorghum (Forage)	Sorg	Sorghum	99118	Sorghum
Sorgo Grano	Sorghum (Grain)	Sorg	Sorghum	99118	Sorghum
Soya	Soybean	Soyb	Soybeans	99119	Soybeans
Tamarindo	Tamarind	Mscp	Mscp	99108	Miscellaneous Crops
Tomate Cherry	Cherry Tomato	Toba	Toba	99120	Tobacco
Tomate Rojo (Jitomate)	Red Tomato (Jitomate)	Toba	Toba	99120	Tobacco
Tomate Rojo (Saladette)	Red Tomato (Salad)	Toba	Toba	99120	Tobacco
Tomate Rojo (Semilla)	Red Tomato (Seed)	Toba	Toba	99120	Tobacco
Tomate Verde	Green Tomato	Toba	Toba	99120	Tobacco
Tomillo	Thyme	Mscp	Mscp	99108	Miscellaneous Crops
Toronja (Pomelo)	Grapefruit (Pomelo)	Citr	Citr-B2	98027	Citrus
Trebol	Clover	Mscp	Mscp	99108	Miscellaneous Crops

Table 7-1. Cont.

Crop Name	Crop Name (English)	vegib2 Code	lcVeg Code	lc Code	Description
Trigo Forrajero	Wheat (Forage)	Whea	Wheat	99123	Wheat
Trigo Grano	Wheat (Grain)	Whea	Wheat	99123	Wheat
Triticale Forrajero	Wheat/rye (Forage)	Whea	Wheat	99123	Wheat
Triticale Grano	Wheat/rye (Grain)	Whea	Wheat	99123	Wheat
Tuna	Tuna	Mscp	Mscp	99108	Miscellaneous Crops
Uva (Industrial)	Grape (Industrial)	Mscp	Mscp	99108	Miscellaneous Crops
Uva Fruta	Grape (fruit)	Mscp	Mscp	99108	Miscellaneous Crops
Uva Pasa	Grape (raisin)	Mscp	Mscp	99108	Miscellaneous Crops
Vainilla Beneficiada	Vanilla	Mscp	Mscp	99108	Miscellaneous Crops
Varios	Various	Mscp	Mscp	99108	Miscellaneous Crops
Verdolaga	Purslane	Mscp	Mscp	99108	Miscellaneous Crops
Zacate	Hay	Hay	Hay	99107	Hay
Zacate Ballico	Hay (Ballico)	Hay	Hay	99107	Hay
Zacate Bermuda	Hay (Bermuda)	Hay	Hay	99107	Hay
Zacate Bermuda (Semilla)	Hay (Bermuda seed)	Hay	Hay	99107	Hay
Zacate Buffel	Hay (Buffel)	Hay	Hay	99107	Hay
Zacate Maravilla	Hay (Marigold)	Hay	Hay	99107	Hay
Zanahoria	Carrot	Mscp	Mscp	99108	Miscellaneous Crops

APPENDIX G

STATE LEVEL
EMISSIONS INVENTORY SUMMARIES

Figure G-1. 1999 Emissions Inventory for Baja California (Final)

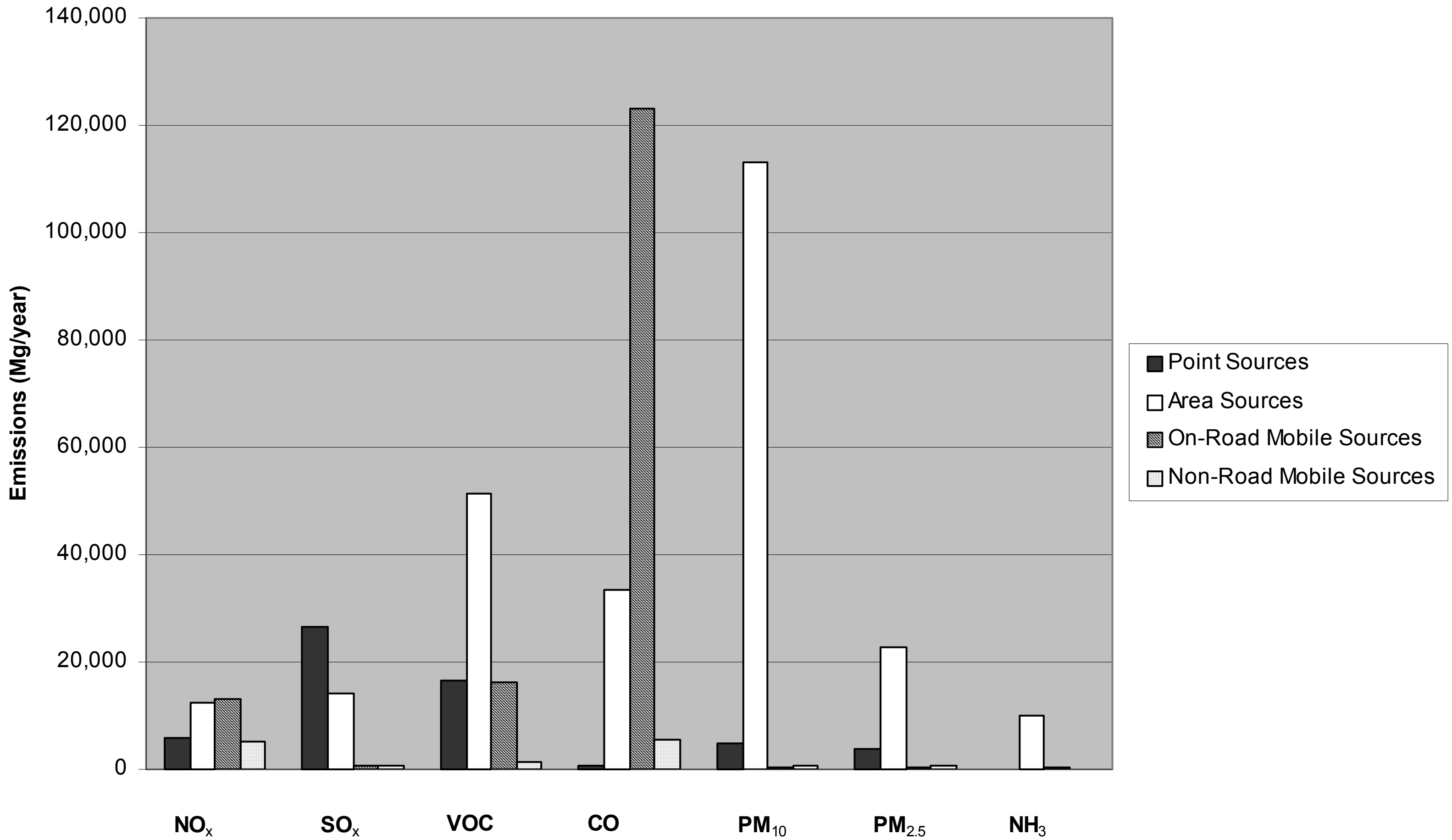


Figure G-2. 1999 Emissions Inventory for Coahuila (Final)

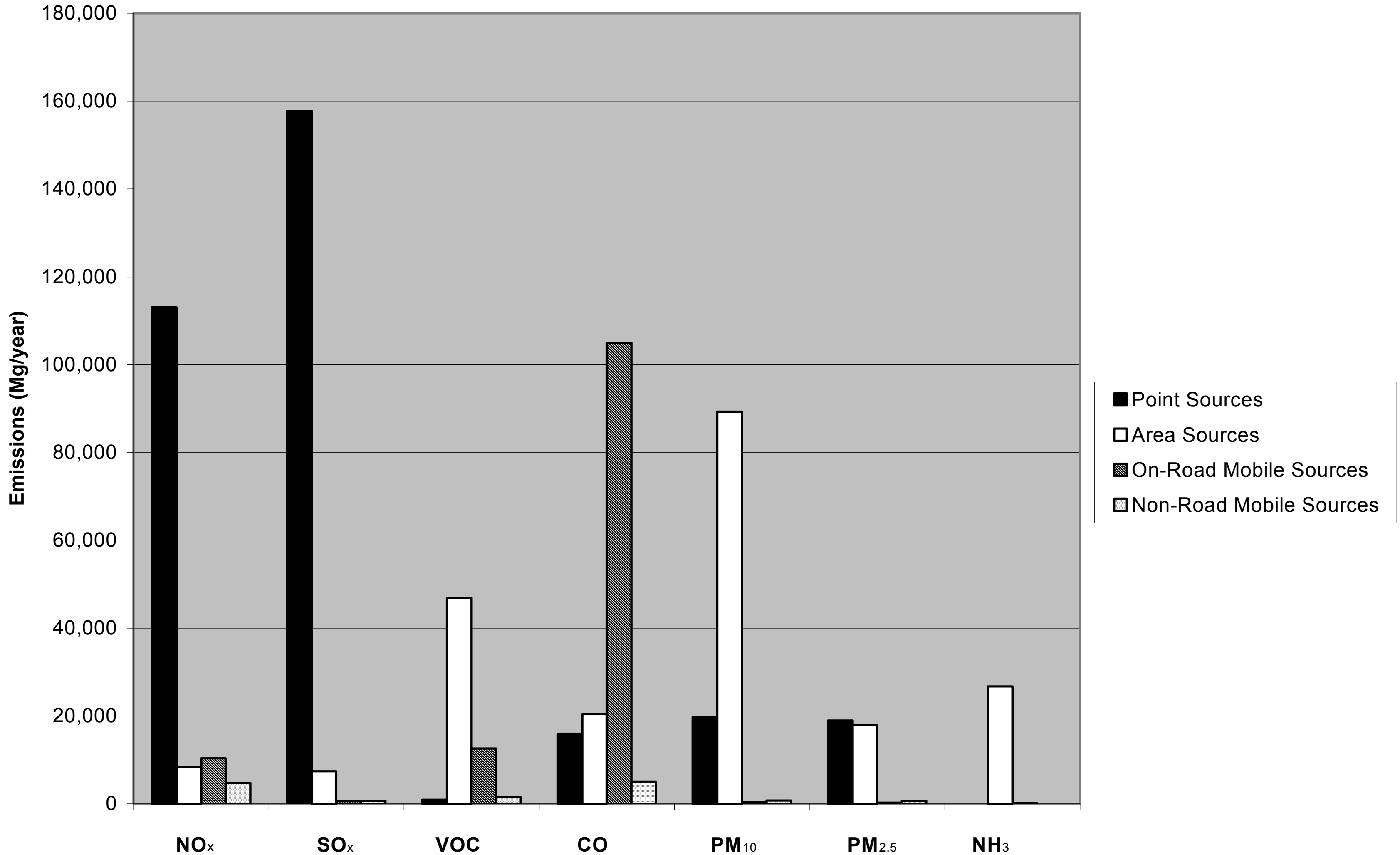


Figure G-3. 1999 Emissions Inventory for Chihuahua (Final)

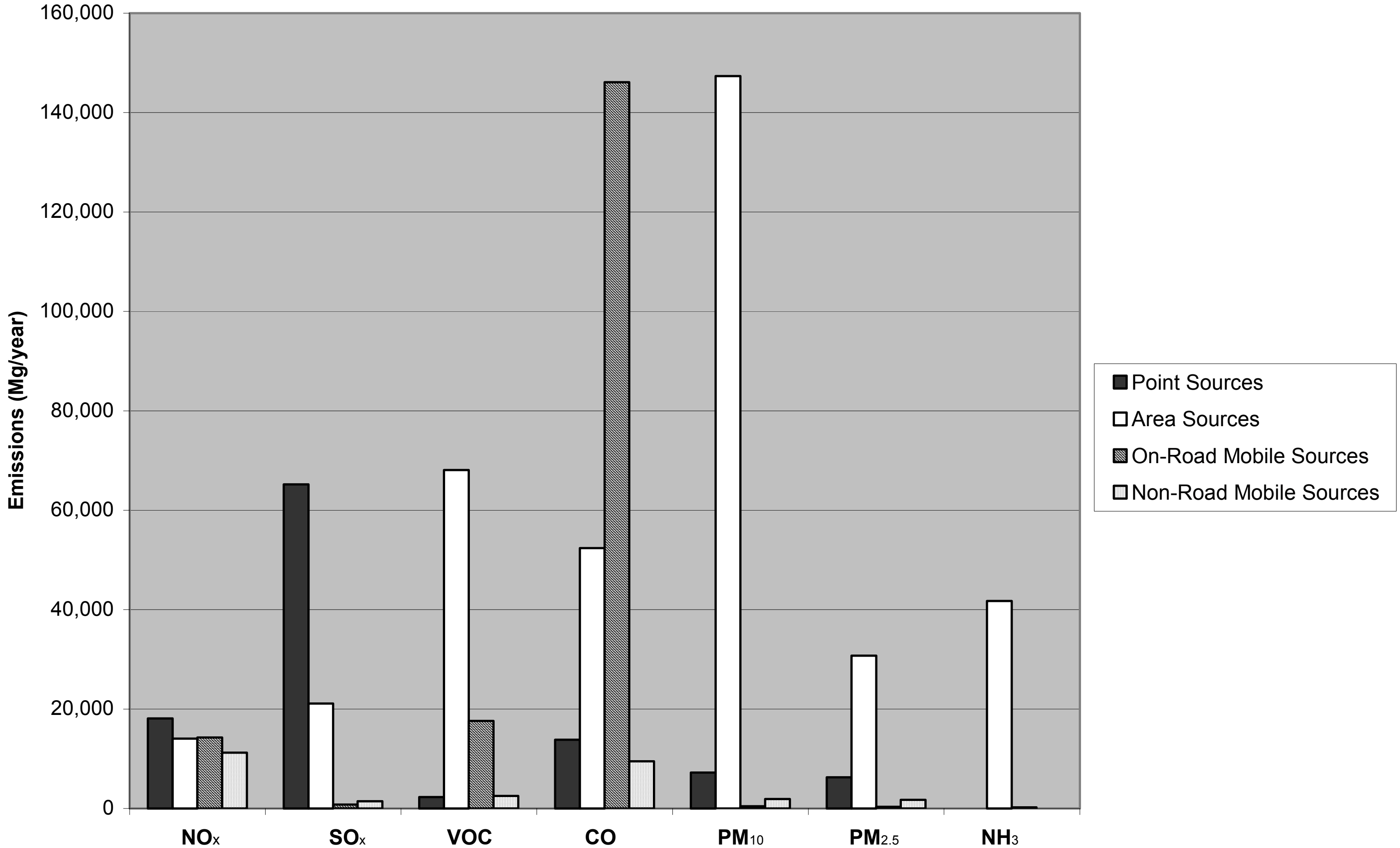


Figure G-4. 1999 Emissions Inventory for Nuevo León (Final)

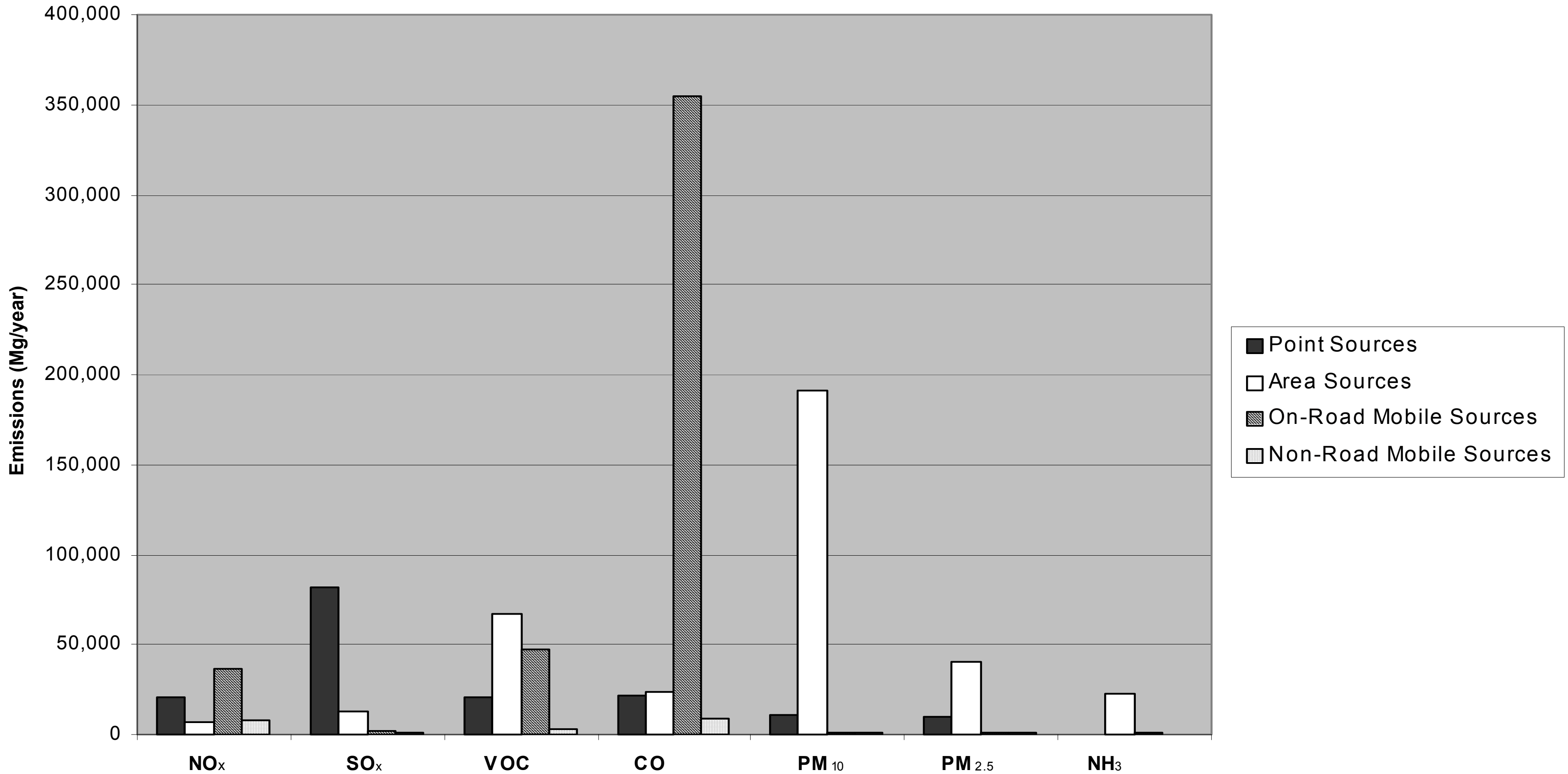


Figure G-5. 1999 Emissions Inventory for Sonora (Final)

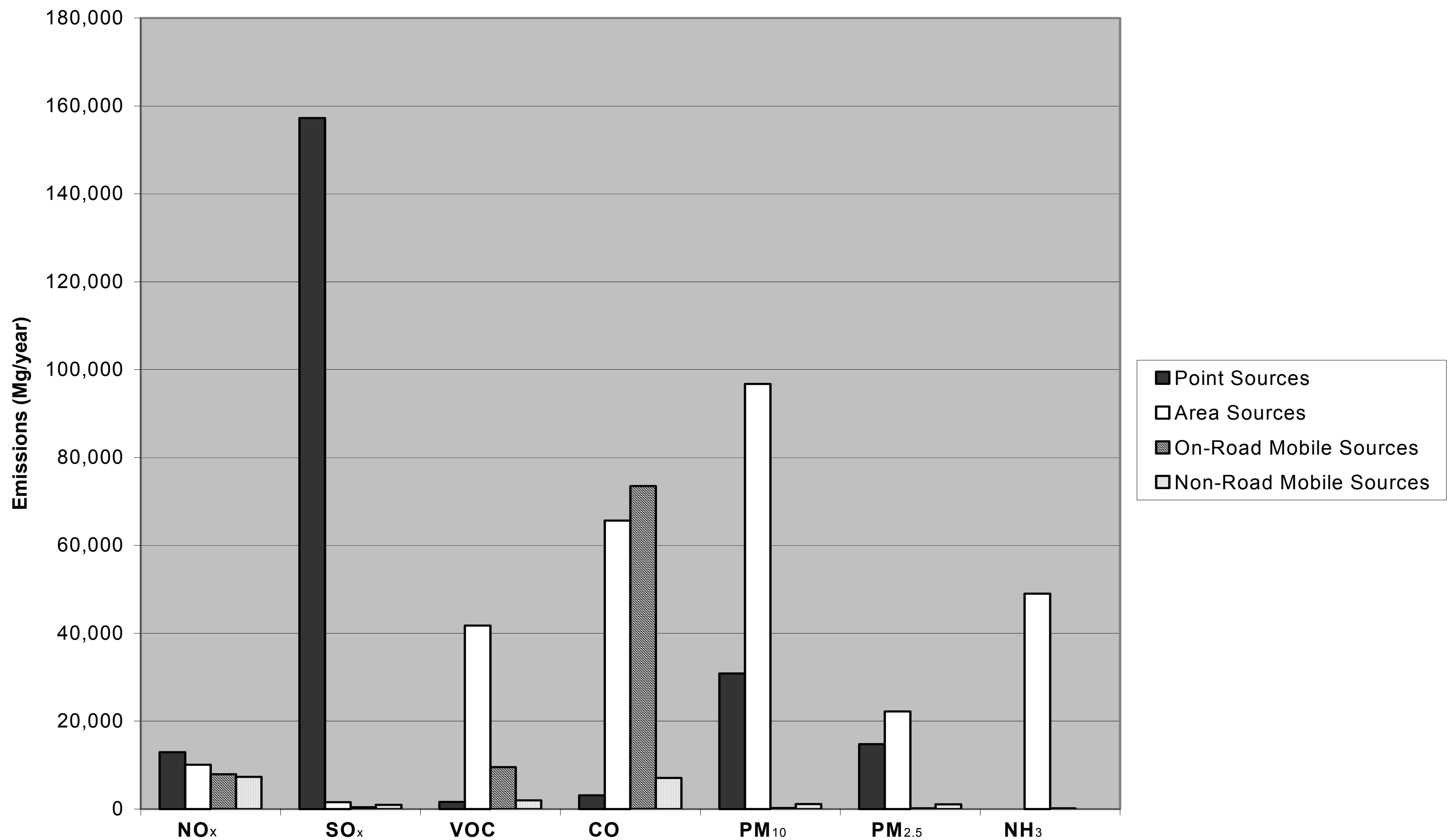
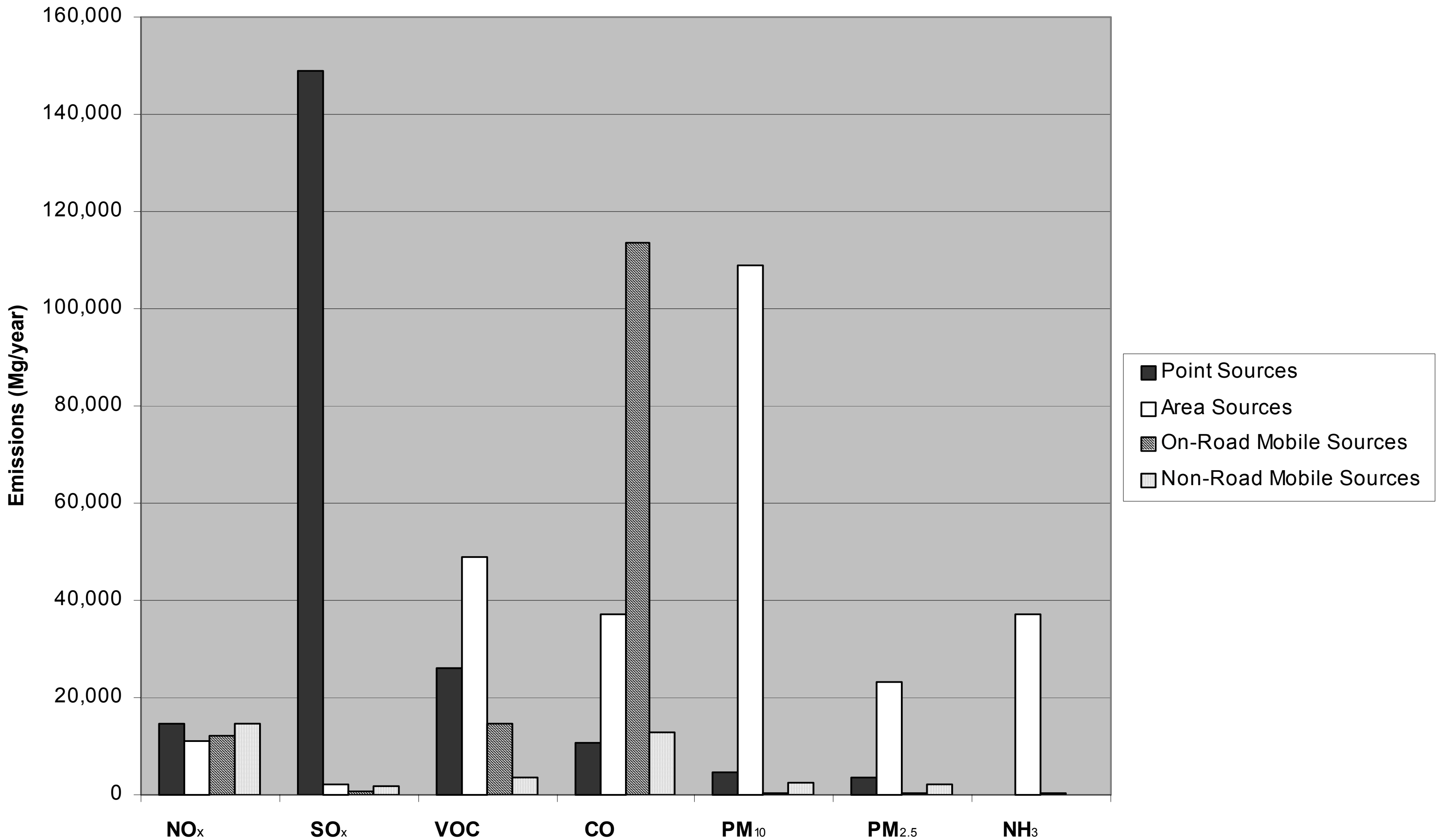


Figure G-6. 1999 Emissions Inventory for Tamaulipas (Final)



APPENDIX H

MUNICIPALITY LEVEL
EMISSIONS INVENTORY SUMMARIES

Total 1999 Emissions Inventory for the Six Northern Mexican States (Final)
Mg/Year, by State, By Municipality
Excludes Natural Sources

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Baja California	Ensenada	7,761.7	1,789.0	16,692.9	17,352.3	14,874.8	3,641.6	3,629.2
Baja California	Mexicali	8,671.1	5,835.0	22,078.4	51,331.2	32,458.1	8,724.4	5,446.2
Baja California	Tecate	551.8	590.4	2,144.5	2,495.6	2,627.7	500.0	88.2
Baja California	Tijuana	12,879.7	9,789.0	41,802.8	87,057.1	65,012.6	12,490.9	1,127.2
Baja California	Playas de Rosarito	6,580.5	24,134.5	2,737.6	4,259.5	3,957.8	2,214.8	71.9
Total - State		***36,444.7***	***42,137.9***	***85,456.2***	***162,495.6***	***118,931.0***	***27,571.8***	***10,362.6***
Coahuila	Abasolo	100.9	10.5	43.2	156.0	79.3	29.1	81.8
Coahuila	Acuña	1,005.2	813.5	3,969.3	5,947.5	5,445.4	1,018.9	1,247.8
Coahuila	Allende	132.9	60.6	394.1	562.8	1,030.2	176.9	138.8
Coahuila	Arteaga	114.8	39.1	437.7	1,145.1	833.8	198.8	389.7
Coahuila	Candela	280.7	38.6	90.6	256.1	151.3	65.5	185.0
Coahuila	Castaños	574.5	151.3	768.8	910.5	1,196.3	266.1	361.4
Coahuila	Cuatrociénegas	324.4	119.7	251.9	507.1	862.4	243.1	278.4
Coahuila	Escobedo	83.8	4.0	55.2	135.4	144.7	30.9	201.4
Coahuila	Francisco I. Madero	239.2	58.2	707.0	1,261.9	1,553.1	279.8	1,144.4
Coahuila	Frontera	920.4	361.8	2,254.1	4,166.2	2,532.1	616.9	132.9
Coahuila	General Cepeda	291.7	17.5	276.1	740.3	628.9	149.9	797.1
Coahuila	Guerrero	164.3	21.3	66.9	167.1	137.5	45.5	783.4
Coahuila	Hidalgo	143.9	20.3	96.5	141.4	273.3	74.9	384.8
Coahuila	Jiménez	1,216.0	156.3	497.6	1,417.9	643.5	230.9	605.3
Coahuila	Juárez	16.7	1.7	57.1	59.5	116.6	23.2	257.5
Coahuila	Lamadrid	33.1	6.8	35.1	72.0	89.9	19.3	58.0
Coahuila	Matamoros	315.8	72.8	1,243.3	2,333.7	3,064.6	534.9	2,577.4
Coahuila	Monclova	8,711.2	4,035.7	5,792.3	12,546.4	15,342.7	9,366.1	462.3
Coahuila	Morelos	337.6	59.0	190.5	401.0	413.0	112.5	242.3
Coahuila	Múzquiz	571.1	346.6	1,093.4	1,907.5	2,105.5	403.2	1,329.1
Coahuila	Nadadores	109.3	10.7	106.2	257.7	306.1	65.7	159.7
Coahuila	Nava	103,926.9	151,139.2	555.4	3,104.2	9,314.2	8,233.1	336.6
Coahuila	Ocampo	753.9	158.1	351.8	1,365.1	795.5	227.4	854.9
Coahuila	Parras	957.3	134.2	992.5	2,107.0	1,674.2	399.0	911.0
Coahuila	Piedras Negras	1,157.7	589.5	4,436.2	6,722.3	6,208.5	1,172.0	329.6
Coahuila	Progreso	114.6	29.7	89.2	172.4	221.6	47.4	322.3
Coahuila	Ramos Arizpe	2,493.3	569.8	3,741.6	7,503.2	1,782.7	579.4	1,087.1
Coahuila	Sabinas	386.1	241.7	1,273.5	1,381.5	1,940.3	418.4	535.6
Coahuila	Sacramento	17.6	2.9	34.2	82.9	101.1	19.9	82.9
Coahuila	Saltillo	5,570.8	1,888.4	15,573.9	43,156.2	23,927.7	7,447.0	1,639.4
Coahuila	San Buenaventura	71.9	14.1	300.5	574.1	966.6	165.8	751.6
Coahuila	San Juan de Sabinas	371.7	963.7	749.6	1,120.1	1,402.8	262.8	194.1
Coahuila	San Pedro	741.0	157.4	1,486.1	2,939.3	3,166.7	643.6	931.6
Coahuila	Sierra Mojada	420.8	35.8	144.1	332.3	324.1	81.8	321.1
Coahuila	Torreón	4,849.2	4,141.2	12,885.2	39,447.7	19,748.9	4,139.2	3,672.6
Coahuila	Viesca	1,731.7	231.5	847.2	2,465.1	1,163.9	374.4	1,185.9
Coahuila	Villa Unión	126.2	15.6	117.8	206.8	317.4	61.5	486.3
Coahuila	Zaragoza	153.8	29.9	281.0	454.6	630.9	119.0	1,416.4
Total - State		***139,531.9***	***166,748.6***	***62,286.6***	***148,227.9***	***110,637.5***	***38,344.0***	***26,877.3***
Chihuahua	Ahumada	491.5	53.1	245.2	418.7	628.4	127.1	987.0
Chihuahua	Aldama	610.8	43.1	349.3	689.0	983.2	197.4	885.2
Chihuahua	Allende	125.0	7.2	146.6	301.3	467.7	85.3	221.7
Chihuahua	Aquiles Serdán	38.7	4.0	60.9	174.4	253.6	45.2	38.0
Chihuahua	Ascensión	465.0	95.8	448.9	1,079.9	1,188.6	255.5	1,105.2
Chihuahua	Bachíniva	57.6	6.8	145.1	307.0	413.1	89.8	533.1
Chihuahua	Balleza	251.2	33.9	507.7	1,714.7	1,074.8	317.5	887.5
Chihuahua	Batopilas	65.9	11.2	387.6	1,364.3	753.4	236.2	299.5
Chihuahua	Bocoyna	289.1	57.9	910.3	2,949.3	1,253.4	436.6	359.4
Chihuahua	Buenaventura	1,706.5	317.4	677.8	1,859.8	1,339.6	472.9	1,004.4
Chihuahua	Camargo	508.4	224.1	817.0	1,521.4	2,279.4	987.1	2,452.1
Chihuahua	Carichí	107.0	13.4	256.7	862.0	530.5	156.2	545.7
Chihuahua	Casas Grandes	191.1	7.5	348.0	1,354.5	607.9	199.4	797.9
Chihuahua	Coronado	157.1	21.2	68.8	208.1	148.3	47.9	240.5
Chihuahua	Coyame del Sotol	135.3	17.5	58.5	156.9	110.1	38.6	639.7
Chihuahua	La Cruz	159.1	14.5	73.7	211.7	210.2	51.6	178.3
Chihuahua	Cuauhtémoc	931.9	480.8	2,481.6	4,219.7	6,345.4	1,278.0	2,836.7
Chihuahua	Cusihuiriachi	28.7	2.2	142.8	253.4	477.4	100.6	1,131.5
Chihuahua	Chihuahua	10,745.3	9,414.2	18,561.0	58,745.3	24,990.0	6,229.0	3,136.8
Chihuahua	Chínipas	47.1	3.8	252.5	1,006.0	443.4	156.9	236.0
Chihuahua	Delicias	4,565.3	39,197.4	2,847.4	4,904.1	8,079.1	3,414.1	1,193.5
Chihuahua	Dr. Belisario Domínguez	52.4	6.2	74.4	182.3	217.5	47.0	256.0
Chihuahua	Galeana	273.1	39.8	106.7	335.1	241.3	81.1	224.4
Chihuahua	Santa Isabel	78.9	11.4	90.2	198.6	297.6	63.8	138.9
Chihuahua	Gómez Farías	106.3	51.6	251.3	543.9	567.3	133.7	341.9
Chihuahua	Gran Morelos	65.6	11.8	81.0	183.3	230.0	51.2	152.1

Total 1999 Emissions Inventory for the Six Northern Mexican States (Final)
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Excludes Natural Sources

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Chihuahua	Guachochi	206.9	36.8	1,314.7	4,449.4	1,926.7	689.4	566.7
Chihuahua	Guadalupe	48.1	18.8	150.9	331.5	522.0	94.5	674.4
Chihuahua	Guadalupe y Calvo	294.0	37.7	1,775.1	7,023.6	2,380.4	969.2	386.4
Chihuahua	Guazapares	157.4	5.8	349.8	1,477.7	565.4	213.7	230.5
Chihuahua	Guerrero	658.1	80.7	957.4	2,535.1	1,737.0	458.2	1,221.8
Chihuahua	Hidalgo del Parral	511.8	377.6	2,578.1	3,149.8	4,830.9	915.7	388.3
Chihuahua	Hejotitán	77.9	10.2	40.7	127.1	83.8	26.9	143.2
Chihuahua	Ignacio Zaragoza	46.6	53.4	234.7	518.5	491.8	118.7	359.3
Chihuahua	Janos	78.2	9.4	197.8	450.7	648.4	134.0	1,293.0
Chihuahua	Jiménez	170.6	83.8	618.5	1,010.7	1,332.1	246.5	1,102.5
Chihuahua	Juárez	23,380.5	35,747.5	42,409.8	89,982.2	69,014.7	14,739.6	1,738.6
Chihuahua	Julimes	243.8	31.9	127.1	330.9	307.8	82.5	656.0
Chihuahua	López	171.3	20.0	103.8	279.6	234.4	55.4	225.3
Chihuahua	Madera	411.7	83.1	950.7	2,716.9	1,496.8	453.6	660.3
Chihuahua	Maguarichi	14.7	1.5	59.0	201.8	114.3	35.6	109.2
Chihuahua	Manuel Benavides	10.7	0.9	35.1	86.9	92.4	20.1	399.2
Chihuahua	Matachí	124.3	8.7	97.9	253.8	218.5	57.6	153.2
Chihuahua	Matamoros	64.7	6.4	92.5	173.0	267.8	52.8	181.5
Chihuahua	Meoqui	166.7	139.4	639.3	1,044.7	1,414.5	255.6	516.9
Chihuahua	Morelos	369.3	47.1	357.1	1,285.6	617.9	223.9	225.2
Chihuahua	Moris	337.0	64.1	266.4	928.6	843.9	274.7	248.7
Chihuahua	Namiquipa	94.2	16.0	517.5	897.7	1,699.0	340.1	1,735.8
Chihuahua	Nonoava	140.5	19.1	113.3	365.8	207.6	65.0	340.1
Chihuahua	Nuevo Casas Grandes	402.5	316.3	1,041.4	1,759.9	1,790.4	340.3	1,338.8
Chihuahua	Ocampo	97.6	12.8	342.9	1,451.6	503.0	201.6	264.1
Chihuahua	Ojinaga	305.4	75.2	531.8	790.1	1,264.8	226.5	458.9
Chihuahua	Praxedis G. Guerrero	139.7	54.1	202.9	389.5	465.8	95.7	229.3
Chihuahua	Riva Palacio	327.0	35.7	284.7	696.0	778.0	186.6	1,472.1
Chihuahua	Rosales	132.0	13.0	211.9	410.2	755.9	131.9	379.1
Chihuahua	Rosario	80.2	11.0	73.5	227.7	164.0	43.3	256.0
Chihuahua	San Francisco de Borja	109.6	18.9	84.2	223.5	156.0	43.1	222.5
Chihuahua	San Francisco de Conchos	13.2	1.5	49.8	82.9	145.9	26.0	139.3
Chihuahua	San Francisco del Oro	970.3	157.2	415.8	1,304.9	421.2	172.2	50.7
Chihuahua	Santa Bárbara	196.8	187.5	274.2	477.8	589.7	122.8	70.5
Chihuahua	Satevó	91.3	11.9	131.7	320.9	340.5	80.6	515.8
Chihuahua	Saucillo	534.1	158.2	560.7	1,133.0	1,102.1	247.7	831.4
Chihuahua	Temósachi	126.7	6.1	247.5	840.0	475.6	146.1	310.6
Chihuahua	El Tule	926.5	127.8	338.0	1,140.8	262.1	146.1	117.0
Chihuahua	Urique	309.3	20.6	594.0	2,186.8	1,125.2	372.4	324.1
Chihuahua	Uruachi	66.4	6.8	268.7	964.8	512.4	166.0	285.1
Chihuahua	Valle de Zaragoza	49.5	7.2	121.7	250.7	316.1	67.3	331.8
Total - State		***54,911.0***	***88,269.2***	***90,153.4***	***220,017.2***	***156,348.3***	***38,638.9***	***41,976.4***
Nuevo Leon	Abasolo	24.5	5.4	45.6	66.6	117.0	20.3	16.6
Nuevo Leon	Agualeguas	26.3	7.9	104.0	115.4	216.2	37.5	299.2
Nuevo Leon	Los Aldamas	100.8	8.5	52.7	125.9	132.1	28.2	212.1
Nuevo Leon	Allende	152.2	49.5	393.3	735.5	890.2	166.7	80.6
Nuevo Leon	Anáhuac	721.5	117.3	543.3	1,183.0	1,003.4	234.7	1,383.4
Nuevo Leon	Apodaca	7,534.8	1,780.5	9,532.8	31,970.3	17,959.4	6,134.7	391.5
Nuevo Leon	Aramberri	55.6	8.4	330.1	1,037.3	829.9	211.7	792.3
Nuevo Leon	Bustamante	359.4	43.9	127.2	368.1	216.5	74.5	137.1
Nuevo Leon	Cadereyta Jiménez	4,434.7	33,176.0	18,840.9	9,381.5	4,691.0	1,932.8	426.6
Nuevo Leon	Carmen	86.2	77.8	221.0	193.8	319.6	60.8	40.2
Nuevo Leon	Cerralvo	82.8	23.8	142.6	285.1	478.2	88.4	285.5
Nuevo Leon	Ciénega de Flores	647.2	167.3	193.9	1,948.2	614.0	170.0	56.6
Nuevo Leon	China	150.0	33.1	236.8	419.0	571.6	112.8	1,279.6
Nuevo Leon	Doctor Arroyo	111.3	16.3	749.1	2,181.5	1,557.3	415.3	1,579.8
Nuevo Leon	Doctor Coss	61.7	2.2	45.5	96.3	123.4	25.0	198.9
Nuevo Leon	Doctor González	302.3	45.2	125.4	319.0	213.0	75.0	189.2
Nuevo Leon	Galeana	182.5	29.4	761.9	2,318.9	1,636.6	415.5	2,098.7
Nuevo Leon	García	1,657.6	2,428.2	1,417.9	4,393.7	1,727.9	515.8	346.0
Nuevo Leon	San Pedro Garza García	2,333.3	992.9	3,839.7	14,659.9	6,716.4	1,545.2	185.8
Nuevo Leon	General Bravo	117.0	18.5	126.6	260.7	312.3	68.8	584.2
Nuevo Leon	General Escobedo	2,867.8	550.3	7,675.4	25,989.7	12,123.9	2,601.3	316.4
Nuevo Leon	General Terán	55.2	10.3	341.5	1,515.9	918.2	256.8	716.5
Nuevo Leon	General Treviño	20.1	3.4	36.9	57.3	88.9	16.7	116.1
Nuevo Leon	General Zaragoza	1,293.8	180.0	614.5	2,057.9	486.0	254.3	364.4
Nuevo Leon	General Zuazua	55.5	98.6	403.0	185.8	290.5	54.4	60.7
Nuevo Leon	Guadalupe	8,337.0	1,847.3	18,083.0	74,879.3	36,309.5	8,595.1	793.2
Nuevo Leon	Los Herreras	79.7	4.3	47.9	95.2	140.8	27.1	173.2
Nuevo Leon	Higueras	10.7	3.3	21.9	44.7	66.4	12.2	191.7
Nuevo Leon	Hualahuises	150.2	24.9	148.1	371.8	330.6	76.1	51.2

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Nuevo Leon	Iurbide	28.9	3.9	75.0	251.3	186.1	47.4	217.5
Nuevo Leon	Juárez	587.6	118.2	1,160.1	3,002.5	3,442.6	746.5	164.6
Nuevo Leon	Lampazos de Naranjo	230.4	14.7	98.8	181.7	278.1	55.4	1,017.0
Nuevo Leon	Linares	286.1	152.2	1,301.5	2,271.6	2,353.9	490.7	779.7
Nuevo Leon	Marín	39.4	9.8	78.5	135.1	224.7	40.7	46.4
Nuevo Leon	Melchor Ocampo	12.4	1.7	20.1	39.2	60.0	10.9	57.1
Nuevo Leon	Mier y Noriega	25.4	2.7	155.1	527.4	368.8	95.7	271.7
Nuevo Leon	Mina	83.2	12.4	95.4	185.4	252.9	49.3	1,112.0
Nuevo Leon	Montemorelos	301.2	99.3	843.7	1,771.1	1,740.2	363.3	549.4
Nuevo Leon	Monterrey	22,216.1	46,244.0	36,069.4	128,249.0	60,525.3	14,968.8	1,192.5
Nuevo Leon	Parás	2,107.2	292.9	745.3	2,532.0	348.1	274.5	363.4
Nuevo Leon	Pesquería	107.5	32.4	2,133.5	537.0	607.0	148.7	106.8
Nuevo Leon	Los Ramones	162.9	10.6	146.3	588.4	375.7	106.8	355.2
Nuevo Leon	Rayones	13.7	2.0	61.0	195.5	143.6	37.8	264.6
Nuevo Leon	Sabinas Hidalgo	179.0	93.5	709.5	803.5	1,034.0	191.2	470.8
Nuevo Leon	Salinas Victoria	221.1	92.2	392.7	556.6	966.1	207.0	508.2
Nuevo Leon	San Nicolás de los Garza	9,119.3	7,150.8	15,902.6	63,022.6	26,307.5	6,116.5	581.6
Nuevo Leon	Hidalgo	677.6	63.1	297.7	762.8	761.0	185.8	47.8
Nuevo Leon	Santa Catarina	3,338.5	1,446.9	11,656.9	26,084.4	11,820.8	2,673.4	538.9
Nuevo Leon	Santiago	173.8	63.3	567.8	1,027.8	1,155.1	224.4	247.9
Nuevo Leon	Vallecillo	35.5	4.3	42.3	74.7	113.1	22.9	541.7
Nuevo Leon	Villaldama	74.0	6.7	61.6	131.7	202.9	37.8	338.6
Total - State		***72,032.2***	***97,672.0***	***137,817.4***	***410,188.6***	***204,348.6***	***51,323.0***	***23,140.6***
Sonora	Aconchi	14.8	1.9	57.0	97.7	125.4	24.6	178.2
Sonora	Agua Prieta	775.5	688.5	1,631.8	2,454.9	2,142.8	447.1	623.5
Sonora	Alamos	169.4	19.9	695.5	2,128.0	1,087.8	350.7	2,384.0
Sonora	Altar	60.6	12.0	132.0	402.4	394.2	86.7	667.8
Sonora	Arivechi	10.5	1.1	31.2	84.7	76.3	17.8	357.6
Sonora	Arizpe	33.4	3.8	84.9	196.3	176.9	42.1	791.0
Sonora	Atil	5.1	0.7	12.3	30.4	35.6	7.2	68.3
Sonora	Bacadéhuachi	8.5	0.9	28.2	76.4	72.7	16.6	321.6
Sonora	Bacanora	5.2	0.5	22.2	54.1	48.8	11.3	400.2
Sonora	Bacerac	7.7	0.9	32.0	101.7	74.7	19.5	292.3
Sonora	Bacoachi	10.4	1.2	31.5	73.0	76.5	16.7	458.2
Sonora	Bácum	263.6	31.3	636.9	4,035.7	1,572.4	585.5	368.2
Sonora	Banámichi	16.3	2.0	33.4	59.8	69.6	14.6	296.1
Sonora	Baviácora	27.4	3.0	77.9	136.1	191.9	36.6	580.2
Sonora	Bavispe	22.8	2.7	30.3	98.2	78.0	20.6	314.7
Sonora	Benjamín Hill	1,092.8	17.5	162.0	327.3	317.6	78.8	328.6
Sonora	Caborca	580.4	113.6	1,099.7	2,226.6	17,794.1	4,962.0	848.8
Sonora	Cajeme	2,648.1	1,798.9	8,639.6	26,272.3	14,622.5	3,935.0	4,497.8
Sonora	Cananea	1,914.5	2,467.8	908.8	2,326.6	4,796.1	1,413.9	806.7
Sonora	Carbó	208.2	13.6	100.2	249.2	266.0	58.2	852.2
Sonora	La Colorada	135.6	42.8	52.0	121.6	708.7	198.8	1,008.6
Sonora	Cucurpe	20.4	2.4	22.3	55.8	55.0	13.6	566.2
Sonora	Cumpas	51.4	11,933.9	107.5	228.4	305.1	59.7	731.5
Sonora	Divisaderos	13.7	1.7	15.3	36.5	41.3	9.2	211.6
Sonora	Empalme	457.6	41.5	1,077.2	1,768.2	1,760.3	360.0	300.7
Sonora	Etchojoa	571.2	72.2	1,421.3	7,133.1	2,731.3	1,015.5	461.2
Sonora	Fronteras	236.2	11.2	168.0	333.3	396.0	84.3	778.0
Sonora	Granados	46.8	6.1	28.5	75.6	66.2	16.8	138.1
Sonora	Guaymas	6,541.1	57,414.6	3,357.9	8,393.8	10,436.3	5,063.8	1,938.1
Sonora	Hermosillo	7,269.9	14,087.6	14,996.6	37,729.5	23,272.8	5,372.7	5,024.1
Sonora	Huachinera	1,278.7	176.2	454.5	1,536.8	241.2	180.7	330.7
Sonora	Huásabas	6.6	0.8	18.9	31.9	47.8	8.9	238.1
Sonora	Huatabampo	404.5	35.3	1,497.5	4,875.9	3,029.5	804.7	717.4
Sonora	Huépac	280.0	37.1	93.8	292.6	95.9	49.8	167.5
Sonora	Imuris	121.2	4.4	183.0	313.1	496.9	89.2	483.7
Sonora	Magdalena	186.3	19.7	550.8	679.6	1,202.1	206.6	495.4
Sonora	Mazatán	14.6	2.0	33.1	63.0	79.2	15.8	312.6
Sonora	Moctezuma	78.8	10.1	135.4	346.5	225.2	59.2	517.4
Sonora	Naco	140.5	5.9	153.0	189.1	259.8	46.9	224.5
Sonora	Nácori Chico	45.8	4.0	182.1	885.1	203.6	106.7	775.8
Sonora	Nacozari de García	1,173.3	2,817.7	275.9	480.8	3,269.7	874.5	305.5
Sonora	Navojoa	857.7	757.7	3,147.6	10,411.5	8,008.9	2,117.1	3,304.5
Sonora	Nogales	1,415.4	158.3	5,191.4	8,825.6	7,842.8	1,429.2	684.0
Sonora	Onavas	368.7	49.9	121.4	412.4	79.4	56.3	153.1
Sonora	Opodepe	401.0	45.9	170.9	524.2	197.6	75.3	663.9
Sonora	Oquitoa	4.6	0.5	8.9	31.0	23.1	5.9	140.2
Sonora	Pitiquito	4,587.3	66,901.8	252.1	975.8	4,615.0	4,163.1	975.6
Sonora	Puerto Peñasco	445.6	37.8	560.3	764.2	1,032.3	184.7	232.3

Total 1999 Emissions Inventory for the Six Northern Mexican States (Final)
Mg/Year, by State, By Municipality
Excludes Natural Sources

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Sonora	Quiriego	66.3	7.9	112.0	361.9	208.9	67.1	886.3
Sonora	Rayón	70.1	9.5	51.9	169.8	98.3	28.6	398.6
Sonora	Rosario	54.1	6.3	146.9	430.3	295.2	82.8	784.8
Sonora	Sahuaripa	27.8	3.2	122.8	310.5	321.4	69.5	1,459.5
Sonora	San Felipe de Jesús	17.7	2.3	11.4	28.3	23.8	6.1	47.0
Sonora	San Javier	19.2	2.6	15.7	34.1	16.9	5.8	146.0
Sonora	San Luis Río Colorado	1,241.1	122.2	3,377.3	10,203.9	7,645.0	1,563.6	528.3
Sonora	San Miguel de Horcasitas	85.3	6.8	108.3	327.8	291.8	67.1	517.5
Sonora	San Pedro de la Cueva	6.5	0.6	32.1	67.9	81.4	16.2	509.8
Sonora	Santa Ana	869.7	155.1	487.0	1,018.1	765.0	223.7	510.2
Sonora	Santa Cruz	182.8	7.9	40.3	118.3	94.8	27.3	302.1
Sonora	Sáric	14.2	1.5	38.8	100.7	112.6	23.3	386.4
Sonora	Soyopa	53.1	6.5	50.5	159.8	93.7	28.4	389.8
Sonora	Suaqui Grande	63.5	7.9	28.5	84.9	70.1	21.4	283.0
Sonora	Tepache	27.0	3.3	27.9	62.5	75.4	16.2	259.4
Sonora	Trincheras	149.0	3.0	45.1	190.9	110.0	33.7	557.9
Sonora	Tubutama	25.9	3.0	40.5	116.3	96.8	24.4	311.5
Sonora	Ures	34.3	3.4	151.4	353.0	479.6	90.5	1,089.5
Sonora	Villa Hidalgo	16.8	1.2	66.4	270.1	120.1	39.0	363.3
Sonora	Villa Pesqueira	28.8	3.4	35.4	74.9	80.7	18.4	564.8
Sonora	Yécora	65.0	11.1	210.8	761.8	346.4	115.3	985.0
Sonora	General Plutarco Elías Calles	49.5	22.2	172.5	324.8	554.3	95.2	347.8
Sonora	Benito Juárez	83.6	11.0	494.2	3,021.4	1,404.3	451.8	39.7
Sonora	San Ignacio Río Muerto	58.3	6.5	311.5	1,921.0	912.3	292.2	171.2
Total - State		***38,339.3***	***160,269.5***	***54,903.7***	***149,459.2***	***129,041.6***	***38,222.2***	***49,155.7***
Tamaulipas	Abasolo	331.5	43.1	661.0	618.4	798.5	191.9	727.9
Tamaulipas	Aldama	464.2	59.7	612.5	1,680.3	1,224.3	338.2	6,451.7
Tamaulipas	Altamira	9,319.7	91,848.8	2,815.0	7,153.3	5,422.0	1,468.9	1,989.2
Tamaulipas	Antiguo Morelos	108.2	37.8	287.8	1,198.6	542.9	180.7	244.1
Tamaulipas	Burgos	143.6	17.5	117.8	360.6	323.5	86.2	1,198.6
Tamaulipas	Bustamante	47.3	4.9	197.5	670.0	473.4	130.2	352.1
Tamaulipas	Camargo	304.8	26.5	498.4	582.0	857.0	165.1	277.7
Tamaulipas	Casas	155.4	12.8	160.1	419.3	383.7	108.1	962.3
Tamaulipas	Ciudad Madero	5,825.7	38,953.1	29,543.9	19,215.2	8,641.3	2,814.6	220.6
Tamaulipas	Cruillas	28.4	3.2	45.6	94.1	138.5	28.9	467.0
Tamaulipas	Gómez Farías	958.6	122.0	471.6	2,018.6	730.6	327.3	157.8
Tamaulipas	González	366.5	30.2	891.1	2,391.6	1,799.3	469.6	2,169.9
Tamaulipas	Güémez	701.8	85.1	422.6	1,306.0	893.1	289.0	531.3
Tamaulipas	Guerrero	195.6	25.3	106.9	242.8	249.6	65.4	892.3
Tamaulipas	Gustavo Díaz Ordaz	128.0	12.3	377.4	415.2	834.8	144.4	148.4
Tamaulipas	Hidalgo	340.8	30.3	542.2	1,447.5	1,386.1	336.1	833.2
Tamaulipas	Jaumave	337.6	41.5	384.9	1,188.3	779.3	239.0	534.0
Tamaulipas	Jiménez	77.0	10.1	159.9	351.1	481.7	99.0	625.8
Tamaulipas	Llera	194.4	11.4	414.3	1,209.5	985.8	252.7	832.3
Tamaulipas	Mainero	263.5	32.9	111.3	370.8	210.4	82.4	179.7
Tamaulipas	El Mante	704.3	88.9	2,070.8	5,084.5	5,775.5	1,423.6	1,023.2
Tamaulipas	Matamoros	5,748.2	1,162.1	11,798.1	26,137.0	15,937.8	3,743.6	1,504.0
Tamaulipas	Méndez	175.0	21.2	179.4	266.9	542.5	128.6	673.1
Tamaulipas	Mier	36.8	7.1	112.7	272.3	326.6	55.1	451.9
Tamaulipas	Miguel Alemán	144.5	31.0	421.2	664.5	871.0	156.2	269.3
Tamaulipas	Miquihuana	29.5	2.9	116.3	442.9	222.1	72.8	216.0
Tamaulipas	Nuevo Laredo	4,603.6	467.3	9,179.4	20,468.0	11,458.8	2,494.7	702.2
Tamaulipas	Nuevo Morelos	33.4	3.9	107.7	535.5	208.7	72.7	145.5
Tamaulipas	Ocampo	140.9	17.0	434.1	1,740.0	881.0	277.7	670.4
Tamaulipas	Padilla	272.3	34.3	287.5	705.2	761.1	183.4	366.9
Tamaulipas	Palmillas	13.8	1.6	54.1	133.3	107.7	27.8	119.7
Tamaulipas	Reynosa	5,218.5	1,159.5	11,558.7	27,937.2	15,247.2	3,467.7	1,129.3
Tamaulipas	Río Bravo	3,650.5	17,270.1	2,329.3	3,771.5	6,594.3	2,237.7	344.8
Tamaulipas	San Carlos	106.6	11.9	233.4	660.6	608.5	154.7	824.3
Tamaulipas	San Fernando	1,496.4	190.4	1,352.7	2,441.7	3,151.7	793.1	1,290.7
Tamaulipas	San Nicolás	5.8	0.6	24.1	81.0	56.5	15.2	86.4
Tamaulipas	Soto la Marina	378.0	48.3	487.8	1,224.8	1,345.0	308.6	4,584.3
Tamaulipas	Tampico	5,668.7	884.9	5,649.0	18,222.1	10,387.8	2,220.9	315.6
Tamaulipas	Tula	178.1	22.2	614.1	1,830.8	1,116.9	325.4	860.6
Tamaulipas	Valle Hermoso	838.3	122.0	1,519.4	1,807.2	2,293.2	493.6	255.9
Tamaulipas	Victoria	2,275.5	470.1	5,093.9	13,875.8	9,501.6	2,141.7	794.1
Tamaulipas	Villagrán	195.5	12.3	171.5	485.9	422.9	111.3	789.5
Tamaulipas	Xicoténcatl	551.2	30.2	629.6	2,433.2	1,585.0	620.1	306.4
Total - State		***52,758.2***	***153,468.4***	***93,246.7***	***174,154.9***	***116,559.1***	***29,344.1***	***37,519.9***
Total - Six States		***394,017.3***	***708,565.6***	***523,863.9***	***1,264,543.5***	***835,866.0***	***223,443.9***	***189,032.5***

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Baja California	Ensenada	20.6	243.8	8,242.0	4.5	817.7	494.6
Baja California	Mexicali	1,055.5	1,829.1	1,367.7	99.3	2,168.6	1,696.3
Baja California	Tecate	5.8	0.1	17.1	1.5		
Baja California	Tijuana	1,087.4	777.2	6,872.8	207.4	87.9	64.2
Baja California	Playas de Rosarito	3,526.1	23,755.0	67.7	445.1	1,623.1	1,594.7
Total - State		***5,695.4***	***26,605.1***	***16,567.3***	***757.8***	***4,697.4***	***3,849.8***
Coahuila	Abasolo						
Coahuila	Acuña						
Coahuila	Allende						
Coahuila	Arteaga						
Coahuila	Candela						
Coahuila	Castaños	22.9	63.2	0.2	3.8	11.9	7.7
Coahuila	Cuatrociénegas		95.1		8.4	198.1	111.4
Coahuila	Escobedo						
Coahuila	Francisco I. Madero	38.9	0.1	0.3	9.8	0.8	0.8
Coahuila	Frontera	20.9	0.1	1.8	17.5	15.2	13.7
Coahuila	General Cepeda						
Coahuila	Guerrero						
Coahuila	Hidalgo						
Coahuila	Jiménez						
Coahuila	Juárez						
Coahuila	Lamadrid						
Coahuila	Matamoros						
Coahuila	Monclova	6,417.3	2,628.6	21.6	217.6	7,313.5	7,146.1
Coahuila	Morelos						
Coahuila	Múzquiz	26.7	194.3	0.0	0.0	19.2	5.7
Coahuila	Nadadores						
Coahuila	Nava	103,706.6	151,063.2	173.8	2,191.4	8,152.1	8,009.2
Coahuila	Ocampo	518.5	119.8	0.0	473.6	135.7	62.5
Coahuila	Parras						
Coahuila	Piedras Negras	45.9	0.2	20.0	31.0	19.8	18.7
Coahuila	Progreso						
Coahuila	Ramos Arizpe	1,548.2	219.1	457.0	4,467.2	274.0	218.7
Coahuila	Sabinas						
Coahuila	Sacramento						
Coahuila	Saltillo	104.8	145.9	200.5	62.0	3,204.5	3,127.9
Coahuila	San Buenaventura						
Coahuila	San Juan de Sabinas	63.4	800.5			35.9	10.5
Coahuila	San Pedro						
Coahuila	Sierra Mojada						
Coahuila	Torreón	588.6	2,418.0	46.4	8,492.0	351.9	207.7
Coahuila	Viesca						
Coahuila	Villa Unión						
Coahuila	Zaragoza						
Total - State		***113,102.6***	***157,748.2***	***921.6***	***15,974.4***	***19,732.7***	***18,940.5***
Chihuahua	Ahumada						
Chihuahua	Aldama						
Chihuahua	Allende						
Chihuahua	Aquiles Serdán						
Chihuahua	Ascensión					5.7	1.6
Chihuahua	Bachíniva						
Chihuahua	Balleza						
Chihuahua	Batopilas						
Chihuahua	Bocoyna						
Chihuahua	Buenaventura						
Chihuahua	Camargo	109.5	6.7	19.8	328.5	695.4	695.4
Chihuahua	Carichí						
Chihuahua	Casas Grandes						
Chihuahua	Coronado						
Chihuahua	Coyame del Sotol						
Chihuahua	La Cruz						
Chihuahua	Cuauhtémoc	13.7			0.0	19.9	5.6
Chihuahua	Cusihuiriachi						
Chihuahua	Chihuahua	4,445.7	5,075.2	328.0	9,288.5	1,840.4	1,389.8
Chihuahua	Chínipas						
Chihuahua	Delicias	3,985.3	38,541.9	381.7	2,034.7	2,406.8	2,361.2
Chihuahua	Dr. Belisario Domínguez						
Chihuahua	Galeana						
Chihuahua	Santa Isabel						
Chihuahua	Gómez Farías						
Chihuahua	Gran Morelos						

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Chihuahua	Guachochi						
Chihuahua	Guadalupe						
Chihuahua	Guadalupe y Calvo						
Chihuahua	Guazapares						
Chihuahua	Guerrero						
Chihuahua	Hidalgo del Parral	4.1	0.0	77.5	40.9	10.7	10.5
Chihuahua	Hejotitán						
Chihuahua	Ignacio Zaragoza						
Chihuahua	Janos						
Chihuahua	Jiménez						
Chihuahua	Juárez	9,567.7	21,539.4	1,501.2	2,092.4	1,741.4	1,663.2
Chihuahua	Julimes						
Chihuahua	López						
Chihuahua	Madera						
Chihuahua	Maguarichi						
Chihuahua	Manuel Benavides						
Chihuahua	Matachí						
Chihuahua	Matamoros						
Chihuahua	Meoqui						
Chihuahua	Morelos						
Chihuahua	Moris	4.2	14.8	0.0	1.0	492.9	138.0
Chihuahua	Namiquipa						
Chihuahua	Nonoava						
Chihuahua	Nuevo Casas Grandes						
Chihuahua	Ocampo						
Chihuahua	Ojinaga						
Chihuahua	Praxedis G. Guerrero						
Chihuahua	Riva Palacio						
Chihuahua	Rosales						
Chihuahua	Rosario						
Chihuahua	San Francisco de Borja						
Chihuahua	San Francisco de Conchos						
Chihuahua	San Francisco del Oro						
Chihuahua	Santa Bárbara	0.6	0.9	0.0	34.9	27.9	13.4
Chihuahua	Satevó						
Chihuahua	Saucillo	2.4	8.6	0.0	0.6	0.1	0.0
Chihuahua	Temósachi						
Chihuahua	El Tule						
Chihuahua	Urique						
Chihuahua	Uruachi						
Chihuahua	Valle de Zaragoza						
Total - State		***18,133.2***	***65,187.6***	***2,308.3***	***13,821.6***	***7,241.3***	***6,278.6***
Nuevo Leon	Abasolo						
Nuevo Leon	Agualeguas						
Nuevo Leon	Los Aldamas						
Nuevo Leon	Allende						
Nuevo Leon	Anáhuac						
Nuevo Leon	Apodaca	3,764.7	476.9	50.3	959.1	3,103.2	2,991.8
Nuevo Leon	Aramberri						
Nuevo Leon	Bustamante						
Nuevo Leon	Cadereyta Jiménez	4,100.2	32,993.2	16,855.3	6,861.6	2,177.7	1,415.5
Nuevo Leon	Carmen						
Nuevo Leon	Cerralvo						
Nuevo Leon	Ciénega de Flores	592.4	139.2	0.2	1,663.9	92.7	81.1
Nuevo Leon	China						
Nuevo Leon	Doctor Arroyo						
Nuevo Leon	Doctor Coss						
Nuevo Leon	Doctor González						
Nuevo Leon	Galeana						
Nuevo Leon	García	1,180.6	2,124.8	13.3	1,384.5	172.0	155.0
Nuevo Leon	San Pedro Garza García	298.3	278.3	8.8	50.8	56.0	55.0
Nuevo Leon	General Bravo						
Nuevo Leon	General Escobedo	6.1	0.1	34.7	220.7	60.3	56.3
Nuevo Leon	General Terán						
Nuevo Leon	General Treviño						
Nuevo Leon	General Zaragoza						
Nuevo Leon	General Zuazua						
Nuevo Leon	Guadalupe	117.1	0.7	10.2	98.4	1,280.2	1,226.6
Nuevo Leon	Los Herreras						
Nuevo Leon	Higueras						
Nuevo Leon	Hualahuises						

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Nuevo Leon	Iurbide						
Nuevo Leon	Juárez						
Nuevo Leon	Lampazos de Naranjo						
Nuevo Leon	Linares						
Nuevo Leon	Marín						
Nuevo Leon	Melchor Ocampo						
Nuevo Leon	Mier y Noriega						
Nuevo Leon	Mina						
Nuevo Leon	Montemorelos						
Nuevo Leon	Monterrey	8,080.0	40,992.3	2,477.8	4,022.8	3,017.3	2,784.2
Nuevo Leon	Parás						
Nuevo Leon	Pesquería	0.0	0.0	2.0	0.0	25.7	24.3
Nuevo Leon	Los Ramones						
Nuevo Leon	Rayones						
Nuevo Leon	Sabinas Hidalgo						
Nuevo Leon	Salinas Victoria						
Nuevo Leon	San Nicolás de los Garza	2,015.0	4,985.8	278.8	6,462.5	552.8	542.5
Nuevo Leon	Hidalgo	380.5	3.1		146.1	67.7	45.6
Nuevo Leon	Santa Catarina	29.1	37.4	949.1	243.9	45.7	44.3
Nuevo Leon	Santiago						
Nuevo Leon	Vallecillo						
Nuevo Leon	Villaldama						
Total - State		***20,563.8***	***82,031.7***	***20,680.5***	***22,114.5***	***10,651.2***	***9,422.2***
Sonora	Aconchi						
Sonora	Agua Prieta	233.0	624.1	4.8	65.4	100.9	69.9
Sonora	Alamos						
Sonora	Altar						
Sonora	Arivechi						
Sonora	Arizpe						
Sonora	Atil						
Sonora	Bacadéhuachi						
Sonora	Bacanora						
Sonora	Bacerac						
Sonora	Bacoachi						
Sonora	Bácum						
Sonora	Banámichi						
Sonora	Baviácora						
Sonora	Bavispe						
Sonora	Benjamín Hill						
Sonora	Caborca	97.5	55.9	0.0	0.4	15,382.5	4,492.6
Sonora	Cajeme	212.4	1,357.7	219.6	14.1	74.6	52.3
Sonora	Cananea	390.5	2,280.5	10.9	137.9	3,560.9	1,039.8
Sonora	Carbó						
Sonora	La Colorada	11.9	39.9	0.1	2.9	588.1	171.7
Sonora	Cucurpe						
Sonora	Cumpas	1.5	11,928.0	0.0	0.4	1.4	0.8
Sonora	Divisaderos						
Sonora	Empalme						
Sonora	Etchojoa						
Sonora	Fronteras						
Sonora	Granados						
Sonora	Guaymas	4,400.8	57,296.4	484.6	1,744.1	3,563.8	3,489.8
Sonora	Hermosillo	2,007.8	13,270.7	586.2	516.0	823.7	560.7
Sonora	Huachinera						
Sonora	Huásabas						
Sonora	Huatabampo						
Sonora	Huépac						
Sonora	Imuris						
Sonora	Magdalena			20.1		0.0	0.0
Sonora	Mazatán						
Sonora	Moctezuma						
Sonora	Naco						
Sonora	Nácori Chico						
Sonora	Nacozari de García	1,020.3	2,805.8		79.5	2,593.8	757.4
Sonora	Navojoa	114.2	653.7	27.5	10.3	46.8	34.7
Sonora	Nogales	5.5	1.1	177.9	9.1	0.8	0.0
Sonora	Onavas						
Sonora	Opodepe						
Sonora	Oquitoa						
Sonora	Pitiquito	4,449.4	66,895.6	85.4	561.6	4,139.0	4,066.4
Sonora	Puerto Peñasco						

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Sonora	Quiriego						
Sonora	Rayón						
Sonora	Rosario						
Sonora	Sahuaripa						
Sonora	San Felipe de Jesús						
Sonora	San Javier						
Sonora	San Luis Río Colorado						
Sonora	San Miguel de Horcasitas						
Sonora	San Pedro de la Cueva						
Sonora	Santa Ana	14.5	51.0	0.0	4.0	0.8	
Sonora	Santa Cruz						
Sonora	Sáric						
Sonora	Soyopa						
Sonora	Suaqui Grande						
Sonora	Tepache						
Sonora	Trincheras						
Sonora	Tubutama						
Sonora	Ures						
Sonora	Villa Hidalgo						
Sonora	Villa Pesqueira						
Sonora	Yécora	1.2	4.1	0.0	0.3	0.1	0.0
Sonora	General Plutarco Elías Calles	3.8	12.1	0.0	0.9	3.5	1.0
Sonora	Benito Juárez						
Sonora	San Ignacio Río Muerto						
Total - State		***12,964.2***	***157,276.7***	***1,617.2***	***3,146.8***	***30,880.6***	***14,737.2***
Tamaulipas	Abasolo						
Tamaulipas	Aldama						
Tamaulipas	Altamira	6,444.9	91,658.1	278.1	1,315.2	376.7	277.1
Tamaulipas	Antiguo Morelos	9.4	26.0	0.1	1.6	4.9	3.1
Tamaulipas	Burgos						
Tamaulipas	Bustamante						
Tamaulipas	Camargo						
Tamaulipas	Casas						
Tamaulipas	Ciudad Madero	4,163.0	38,704.6	25,283.3	8,093.3	2,278.1	1,483.8
Tamaulipas	Cruillas						
Tamaulipas	Gómez Farías						
Tamaulipas	González						
Tamaulipas	Güémez						
Tamaulipas	Guerrero						
Tamaulipas	Gustavo Díaz Ordaz						
Tamaulipas	Hidalgo						
Tamaulipas	Jaumave						
Tamaulipas	Jiménez						
Tamaulipas	Llera						
Tamaulipas	Mainero						
Tamaulipas	El Mante						
Tamaulipas	Matamoros	38.8	443.3	109.4	230.5	381.5	286.1
Tamaulipas	Méndez						
Tamaulipas	Mier						
Tamaulipas	Miguel Alemán						
Tamaulipas	Miquihuana						
Tamaulipas	Nuevo Laredo	1,343.9	11.6	141.0	332.1	279.8	172.6
Tamaulipas	Nuevo Morelos						
Tamaulipas	Ocampo						
Tamaulipas	Padilla						
Tamaulipas	Palmillas						
Tamaulipas	Reynosa	390.8	519.7	314.8	178.3	298.9	269.6
Tamaulipas	Río Bravo	2,308.0	17,075.4	78.3	495.4	1,117.3	1,083.3
Tamaulipas	San Carlos						
Tamaulipas	San Fernando						
Tamaulipas	San Nicolás						
Tamaulipas	Soto la Marina						
Tamaulipas	Tampico	57.1	300.9	0.4	8.1	30.5	19.7
Tamaulipas	Tula						
Tamaulipas	Valle Hermoso			10.2		2.0	1.8
Tamaulipas	Victoria	0.8	18.3	0.0	0.1	0.4	0.3
Tamaulipas	Villagrán						
Tamaulipas	Xicoténcatl						
Total - State		***14,756.6***	***148,757.9***	***26,215.7***	***10,654.7***	***4,770.1***	***3,597.4***
Total - Six States		***185,215.9***	***637,607.2***	***68,310.5***	***66,469.8***	***77,973.3***	***56,825.7***

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Baja California	Ensenada	5,576.9	1,355.7	6,587.6	4,050.9	13,891.8	2,999.1	3,594.6
Baja California	Mexicali	1,921.6	3,523.5	15,823.6	15,696.0	29,855.9	6,640.1	5,375.0
Baja California	Tecate	296.7	568.3	1,904.8	969.3	2,609.9	484.1	86.0
Baja California	Tijuana	3,673.7	8,542.8	25,120.5	12,191.0	64,671.2	12,217.4	992.8
Baja California	Playas de Rosarito	1,012.4	106.6	1,852.5	426.3	2,067.4	374.6	70.1
Total - State		***12,481.3***	***14,097.0***	***51,289.0***	***33,333.5***	***113,096.3***	***22,715.3***	***10,118.5***
Coahuila	Abasolo	32.7	1.7	26.8	82.9	67.6	18.4	81.8
Coahuila	Acuña	399.7	770.9	3,329.1	1,151.2	5,412.7	990.5	1,239.3
Coahuila	Allende	41.0	51.7	333.9	127.5	1,020.3	168.0	138.2
Coahuila	Arteaga	37.2	33.4	357.3	403.2	829.4	194.9	387.9
Coahuila	Candela	3.2	2.8	35.9	26.6	101.3	19.5	184.9
Coahuila	Castaños	171.4	42.3	657.4	251.3	1,120.9	200.2	360.8
Coahuila	Cuatrociénegas	277.4	20.1	215.4	243.0	660.5	128.3	278.0
Coahuila	Escobedo	61.4	1.4	42.9	63.6	142.2	28.6	201.3
Coahuila	Francisco I. Madero	70.1	47.7	581.8	361.1	1,544.1	271.7	1,143.0
Coahuila	Frontera	189.2	296.7	1,746.4	467.2	2,443.8	537.2	126.7
Coahuila	General Cepeda	192.0	5.7	225.0	390.4	616.7	138.7	796.8
Coahuila	Guerrero	2.9	0.7	34.0	17.8	108.4	18.8	783.3
Coahuila	Hidalgo	2.5	2.2	67.6	14.9	248.0	51.6	384.8
Coahuila	Jiménez	129.4	9.4	146.5	99.1	485.0	85.1	605.0
Coahuila	Juárez	3.8	0.2	50.1	18.3	115.1	21.8	257.5
Coahuila	Lamadrid	3.3	3.2	26.0	19.3	85.1	14.8	57.9
Coahuila	Matamoros	127.6	61.7	1,019.8	639.1	3,058.2	529.5	2,574.8
Coahuila	Monclova	417.4	1,244.4	4,278.9	1,399.7	7,861.8	2,069.4	444.2
Coahuila	Morelos	14.5	18.4	120.2	52.7	355.2	59.4	242.1
Coahuila	Múzquiz	232.7	119.7	884.6	559.1	2,054.7	368.8	1,327.3
Coahuila	Nadadores	36.5	2.1	81.0	101.9	294.7	55.2	159.6
Coahuila	Nava	164.2	72.1	324.5	469.0	1,159.2	221.3	335.9
Coahuila	Ocampo	188.6	34.0	318.5	645.8	655.2	160.7	854.5
Coahuila	Parras	590.6	93.0	834.3	911.8	1,619.2	348.6	909.8
Coahuila	Piedras Negras	369.6	535.1	3,668.5	1,092.3	6,142.6	1,112.7	319.8
Coahuila	Progreso	48.5	21.3	61.7	39.3	212.9	39.5	322.2
Coahuila	Ramos Arizpe	616.2	322.4	3,013.7	612.0	1,478.8	333.8	1,083.4
Coahuila	Sabinas	212.9	226.3	1,123.1	369.1	1,926.7	406.0	534.1
Coahuila	Sacramento	2.9	1.2	25.8	32.7	99.5	18.4	82.9
Coahuila	Saltillo	1,661.3	1,485.7	11,186.7	4,153.9	20,527.3	4,148.7	1,585.5
Coahuila	San Buenaventura	28.3	11.4	252.0	191.6	965.1	164.5	751.0
Coahuila	San Juan de Sabinas	91.5	139.8	606.1	248.8	1,344.6	232.1	193.0
Coahuila	San Pedro	254.6	107.4	1,219.1	1,102.7	3,103.7	586.2	929.1
Coahuila	Sierra Mojada	274.8	17.7	104.8	109.8	299.4	59.1	320.9
Coahuila	Torreón	1,159.7	1,537.2	9,259.4	3,383.8	19,286.7	3,838.9	3,623.3
Coahuila	Viesca	134.0	13.4	270.1	300.1	946.8	174.7	1,185.4
Coahuila	Villa Unión	65.3	8.6	93.8	54.4	308.4	53.1	486.1
Coahuila	Zaragoza	103.2	25.1	245.8	195.7	625.8	114.4	1,416.1
Total - State		***8,412.1***	***7,387.7***	***46,868.6***	***20,402.7***	***89,327.4***	***17,983.3***	***26,707.9***
Chihuahua	Ahumada	417.5	45.2	207.6	157.2	618.7	118.2	986.7
Chihuahua	Aldama	412.4	19.9	268.9	193.8	954.5	171.1	884.7
Chihuahua	Allende	105.2	5.8	124.6	94.4	466.8	84.5	221.4
Chihuahua	Aquiles Serdán	5.3	0.4	43.5	31.1	249.2	41.1	37.9
Chihuahua	Ascensión	288.2	76.2	373.7	573.4	1,157.1	230.3	1,104.6
Chihuahua	Bachíniva	8.6	1.4	122.1	127.3	406.3	83.6	532.9
Chihuahua	Balleza	32.1	7.6	426.2	1,165.6	1,041.6	287.1	887.0
Chihuahua	Batopilas	28.2	8.1	353.5	1,112.6	751.1	234.1	299.1
Chihuahua	Bocoyna	224.6	53.5	838.5	2,275.3	1,250.6	434.2	358.6
Chihuahua	Buenaventura	52.2	106.7	352.5	283.2	1,037.9	195.5	1,003.9
Chihuahua	Camargo	308.0	212.1	684.8	367.1	1,581.1	289.3	2,450.8
Chihuahua	Carichí	16.8	2.2	212.8	593.1	519.5	146.1	545.5
Chihuahua	Casas Grandes	159.1	4.8	319.5	1,103.6	605.6	197.3	797.6
Chihuahua	Coronado	3.1	1.3	32.9	39.9	121.7	23.4	240.4
Chihuahua	Coyame del Sotol	2.3	0.5	30.7	32.1	86.3	16.8	639.6
Chihuahua	La Cruz	53.5	1.3	45.7	49.7	192.3	35.1	178.2
Chihuahua	Cuauhtémoc	384.0	429.3	2,116.8	1,140.7	6,264.1	1,216.7	2,827.1
Chihuahua	Cusihuiriachi	7.3	0.2	126.3	107.3	475.4	98.8	1,131.4
Chihuahua	Chihuahua	2,468.1	4,118.3	13,459.3	4,456.3	23,032.1	4,742.5	3,074.2
Chihuahua	Chínipas	22.0	1.5	233.8	868.4	441.1	154.8	235.8
Chihuahua	Delicias	343.3	641.5	2,179.3	773.7	5,663.5	1,045.4	1,184.5
Chihuahua	Dr. Belisario Domínguez	5.0	0.5	55.6	56.6	210.6	40.7	255.9
Chihuahua	Galeana	5.9	5.8	52.6	65.5	192.8	36.5	224.3
Chihuahua	Santa Isabel	6.0	2.7	66.7	39.5	285.8	53.0	138.8
Chihuahua	Gómez Farías	23.9	41.9	211.7	270.1	556.6	123.9	341.7
Chihuahua	Gran Morelos	6.0	4.6	61.2	51.8	220.5	42.5	152.0

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Chihuahua	Guachochi	100.4	28.8	1,209.9	3,652.8	1,921.0	684.4	565.6
Chihuahua	Guadalupe	15.3	15.9	123.0	127.9	519.6	92.3	674.1
Chihuahua	Guadalupe y Calvo	149.3	25.9	1,646.0	5,836.0	2,369.2	959.2	385.0
Chihuahua	Guazapares	135.0	4.1	328.4	1,280.4	563.9	212.4	230.3
Chihuahua	Guerrero	391.5	50.2	798.3	1,388.0	1,708.4	432.2	1,220.7
Chihuahua	Hidalgo del Parral	279.1	361.9	2,234.2	770.7	4,808.8	895.3	380.5
Chihuahua	Hejotitán	1.7	0.2	20.1	34.4	71.4	15.5	143.2
Chihuahua	Ignacio Zaragoza	26.3	51.9	214.0	327.4	490.6	117.7	359.1
Chihuahua	Janos	13.0	2.1	159.7	209.3	641.3	127.5	1,292.7
Chihuahua	Jiménez	60.8	74.9	516.1	289.6	1,324.1	239.3	1,101.4
Chihuahua	Juárez	5,606.7	13,743.7	30,889.4	11,483.3	67,029.3	12,876.3	1,603.4
Chihuahua	Julimes	6.4	1.0	64.0	44.4	268.7	46.5	655.9
Chihuahua	López	42.0	2.8	54.9	47.6	216.8	39.2	225.2
Chihuahua	Madera	312.6	75.0	858.0	1,875.7	1,490.1	447.6	659.3
Chihuahua	Maguarichi	3.8	0.3	52.7	152.5	112.9	34.4	109.1
Chihuahua	Manuel Benavides	2.4	0.1	29.8	49.5	91.5	19.3	399.2
Chihuahua	Matachí	71.0	2.1	79.4	138.0	210.3	50.1	153.1
Chihuahua	Matamoros	52.2	5.4	80.5	63.8	267.1	52.1	181.4
Chihuahua	Meoqui	80.1	134.0	542.4	281.5	1,411.4	253.1	515.8
Chihuahua	Morelos	18.7	1.5	253.7	810.7	562.6	173.0	224.9
Chihuahua	Moris	12.5	5.8	148.3	464.6	308.0	97.2	248.5
Chihuahua	Namiquipa	31.0	11.1	454.2	317.9	1,695.3	336.9	1,735.1
Chihuahua	Nonoava	5.0	1.0	66.9	158.2	188.1	47.1	340.0
Chihuahua	Nuevo Casas Grandes	284.4	308.6	900.3	503.5	1,784.9	335.5	1,337.3
Chihuahua	Ocampo	33.8	5.2	310.2	1,226.8	495.2	194.4	263.9
Chihuahua	Ojinaga	220.9	67.6	464.6	296.3	1,257.8	220.2	458.2
Chihuahua	Praxedis G. Guerrero	20.5	39.3	152.8	118.2	449.8	81.0	229.0
Chihuahua	Riva Palacio	64.5	1.2	183.8	191.5	742.2	153.7	1,471.8
Chihuahua	Rosales	92.9	10.1	173.7	117.8	753.7	130.0	378.7
Chihuahua	Rosario	3.8	0.8	44.1	86.5	153.7	33.9	255.9
Chihuahua	San Francisco de Borja	4.5	4.9	47.1	58.5	141.2	29.5	222.4
Chihuahua	San Francisco de Conchos	4.1	0.7	41.9	25.2	145.3	25.4	139.2
Chihuahua	San Francisco del Oro	13.9	25.7	82.4	61.4	289.9	51.4	50.5
Chihuahua	Santa Bárbara	130.6	179.4	232.8	122.0	554.8	103.1	70.2
Chihuahua	Satevó	7.1	1.1	96.3	144.9	329.5	70.5	515.7
Chihuahua	Saucillo	101.9	96.9	401.7	235.5	1,038.4	189.4	830.5
Chihuahua	Temósachi	94.1	2.8	225.3	656.1	472.3	143.0	310.4
Chihuahua	El Tule	2.9	0.6	31.9	45.9	131.8	26.2	116.9
Chihuahua	Urique	169.6	4.8	529.3	1,767.9	1,106.3	355.0	323.6
Chihuahua	Uruachi	18.6	1.7	242.0	782.3	506.6	160.7	284.9
Chihuahua	Valle de Zaragoza	8.2	2.5	100.4	119.5	311.1	62.7	331.6
Total - State		***14,082.1***	***21,146.7***	***68,085.0***	***52,393.4***	***147,318.1***	***30,757.3***	***41,728.8***
Nuevo Leon	Abasolo	14.5	4.5	37.9	13.2	116.2	19.6	16.5
Nuevo Leon	Agualeguas	3.8	5.5	89.8	18.9	213.9	35.3	299.1
Nuevo Leon	Los Aldamas	41.8	0.8	28.4	15.8	124.5	21.2	212.0
Nuevo Leon	Allende	24.1	36.8	308.8	143.2	877.0	154.8	79.8
Nuevo Leon	Anáhuac	146.3	40.4	313.9	193.5	929.0	166.3	1,382.8
Nuevo Leon	Apodaca	685.1	1,136.0	5,515.1	1,510.1	14,764.5	3,067.0	343.7
Nuevo Leon	Aramberri	18.2	5.7	292.0	734.2	828.0	210.1	791.9
Nuevo Leon	Bustamante	50.6	3.3	43.4	26.3	167.1	29.1	137.0
Nuevo Leon	Cadereyta Jiménez	178.0	173.2	1,797.3	1,147.5	2,507.5	512.4	424.5
Nuevo Leon	Carmen	42.0	72.9	196.9	38.3	314.4	56.1	40.0
Nuevo Leon	Cerralvo	8.6	15.4	107.2	59.9	468.5	79.5	285.2
Nuevo Leon	Ciénega de Flores	10.3	23.7	159.6	46.5	517.8	85.6	56.3
Nuevo Leon	China	10.4	16.2	178.2	88.8	552.4	95.3	1,279.2
Nuevo Leon	Doctor Arroyo	37.7	11.6	663.7	1,371.7	1,554.6	413.0	1,578.8
Nuevo Leon	Doctor Coss	49.8	0.9	37.8	45.7	122.2	23.9	198.9
Nuevo Leon	Doctor González	3.2	6.6	55.9	24.2	161.9	28.0	189.1
Nuevo Leon	Galeana	42.5	16.5	644.0	1,308.1	1,625.9	405.9	2,097.5
Nuevo Leon	García	175.2	286.2	1,027.2	212.5	1,545.7	352.2	341.2
Nuevo Leon	San Pedro Garza García	186.0	578.3	1,850.2	475.3	6,560.3	1,402.0	164.6
Nuevo Leon	General Bravo	4.8	4.7	90.8	68.5	294.7	52.7	584.0
Nuevo Leon	General Escobedo	286.2	413.4	4,287.4	805.6	11,991.9	2,486.3	277.1
Nuevo Leon	General Terán	12.6	7.0	300.9	1,209.7	915.8	254.7	716.1
Nuevo Leon	General Treviño	1.4	1.1	28.2	8.9	86.5	14.5	116.0
Nuevo Leon	General Zaragoza	12.0	2.9	163.5	443.2	312.2	94.5	364.2
Nuevo Leon	General Zuazua	16.1	94.2	378.5	37.7	286.4	50.7	60.6
Nuevo Leon	Guadalupe	760.7	1,451.0	8,352.1	2,415.9	34,822.6	7,199.1	680.4
Nuevo Leon	Los Herreras	55.4	1.5	36.0	23.5	137.8	24.3	173.1
Nuevo Leon	Higueras	1.3	2.2	16.3	10.9	65.5	11.3	191.6
Nuevo Leon	Hualahuises	6.0	6.0	88.4	97.1	312.1	59.1	51.0

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Nuevo Leon	Iurbide	4.1	1.1	61.6	151.1	183.1	44.6	217.4
Nuevo Leon	Juárez	86.2	71.3	776.7	331.8	3,396.2	704.6	153.4
Nuevo Leon	Lampazos de Naranjo	183.1	9.3	79.2	54.4	271.2	49.1	1,016.8
Nuevo Leon	Linares	148.4	144.3	1,132.0	1,021.7	2,349.4	486.9	777.7
Nuevo Leon	Marín	3.9	5.8	60.9	22.2	220.1	36.6	46.3
Nuevo Leon	Melchor Ocampo	0.9	0.3	14.1	5.5	58.7	9.7	57.1
Nuevo Leon	Mier y Noriega	8.5	1.5	136.7	355.7	368.1	95.0	271.5
Nuevo Leon	Mina	56.8	9.6	78.3	72.0	250.3	46.9	1,111.8
Nuevo Leon	Montemorelos	182.5	91.4	711.5	802.7	1,734.5	358.4	547.9
Nuevo Leon	Monterrey	1,651.7	4,580.0	17,435.2	4,093.6	57,148.5	11,888.5	1,005.5
Nuevo Leon	Parás	1.0	0.5	17.0	8.7	60.9	10.3	363.4
Nuevo Leon	Pesquería	81.7	30.7	2,103.6	319.4	580.3	123.5	106.5
Nuevo Leon	Los Ramones	90.6	2.0	117.7	419.2	365.3	97.3	355.0
Nuevo Leon	Rayones	3.3	1.0	53.1	140.1	142.8	37.0	264.5
Nuevo Leon	Sabinas Hidalgo	31.8	78.6	605.7	140.5	1,019.2	177.8	469.9
Nuevo Leon	Salinas Victoria	131.7	83.1	332.4	143.5	957.4	199.1	507.7
Nuevo Leon	San Nicolás de los Garza	632.8	1,741.2	8,090.0	1,769.5	25,473.2	5,330.5	497.9
Nuevo Leon	Hidalgo	29.0	25.1	181.3	62.4	659.8	109.4	47.4
Nuevo Leon	Santa Catarina	362.1	1,216.3	7,278.3	899.9	11,646.8	2,518.0	500.6
Nuevo Leon	Santiago	34.7	49.9	454.4	289.6	1,143.7	214.0	246.9
Nuevo Leon	Vallecillo	1.6	0.3	31.5	11.7	107.6	17.9	541.7
Nuevo Leon	Villaldama	49.6	4.1	47.4	36.5	200.2	35.3	338.5
Total - State		***6,660.7***	***12,565.6***	***66,888.0***	***23,746.5***	***191,514.3***	***39,994.9***	***22,577.8***
Sonora	Aconchi	3.9	0.8	49.4	45.5	124.4	23.7	178.2
Sonora	Agua Prieta	274.5	37.5	1,429.4	1,129.4	2,016.3	354.0	621.7
Sonora	Alamos	45.4	7.1	614.5	1,577.8	1,075.2	339.2	2,383.2
Sonora	Altar	9.3	6.3	105.9	233.0	387.6	80.7	667.6
Sonora	Arivechi	2.2	0.2	26.2	51.6	75.4	17.0	357.5
Sonora	Arizpe	6.9	0.9	72.4	115.4	173.4	38.9	790.9
Sonora	Atil	1.0	0.3	10.0	14.4	35.2	6.8	68.3
Sonora	Bacadéhuachi	1.9	0.2	23.9	47.0	72.0	16.0	321.5
Sonora	Bacanora	1.4	0.2	19.3	34.1	48.5	11.0	400.1
Sonora	Bacerac	2.3	0.4	27.9	72.7	74.3	19.1	292.2
Sonora	Bacoachi	2.0	0.3	26.5	39.7	75.6	15.8	458.1
Sonora	Bácum	24.4	3.5	545.8	3,479.5	1,536.7	552.8	367.6
Sonora	Banámichi	2.2	0.4	27.5	22.8	67.6	12.7	296.1
Sonora	Baviácora	7.8	1.0	65.7	53.8	189.8	34.7	580.1
Sonora	Bavispe	2.0	0.2	23.5	58.7	74.7	17.6	314.6
Sonora	Benjamín Hill	1,038.9	11.0	133.7	168.9	311.6	73.3	328.5
Sonora	Caborca	335.7	48.5	927.1	957.2	2,405.9	464.5	846.9
Sonora	Cajeme	724.1	317.0	6,663.0	13,167.9	14,450.4	3,797.2	4,464.6
Sonora	Cananea	195.9	15.0	481.5	257.5	1,031.1	186.5	805.8
Sonora	Carbó	115.0	1.8	63.3	67.5	253.3	46.6	852.0
Sonora	La Colorada	108.2	1.2	42.8	62.8	118.9	25.6	1,008.5
Sonora	Cucurpe	1.3	0.1	16.9	25.6	51.8	10.7	566.2
Sonora	Cumpas	8.7	1.4	85.8	85.2	298.6	54.3	731.3
Sonora	Divisaderos	1.0	0.1	11.2	12.7	39.3	7.3	211.6
Sonora	Empalme	216.5	16.7	913.0	719.9	1,735.2	337.2	299.3
Sonora	Etchojoa	72.9	15.7	1,203.6	5,757.0	2,661.8	952.0	459.6
Sonora	Fronteras	167.4	3.4	137.8	142.3	386.4	75.5	777.8
Sonora	Granados	1.4	0.3	14.5	12.4	59.3	10.4	138.0
Sonora	Guaymas	1,884.3	103.9	2,556.2	4,298.0	6,864.4	1,567.2	1,928.1
Sonora	Hermosillo	1,310.9	543.5	10,319.7	6,174.9	22,241.5	4,630.8	4,967.3
Sonora	Huachinera	2.4	0.3	27.1	60.5	62.2	16.0	330.7
Sonora	Huásabas	1.2	0.2	15.6	10.1	47.2	8.4	238.1
Sonora	Huatabampo	248.3	26.1	1,312.7	3,463.0	3,024.3	800.4	715.3
Sonora	Huépac	1.5	0.2	18.4	10.8	51.6	9.1	167.5
Sonora	Imuris	98.3	2.9	158.3	121.0	495.9	88.4	483.4
Sonora	Magdalena	107.0	12.9	464.0	186.7	1,196.2	201.3	494.7
Sonora	Mazatán	2.1	0.6	26.9	24.5	77.6	14.4	312.6
Sonora	Moctezuma	13.7	1.9	107.5	205.1	216.8	51.4	517.3
Sonora	Naco	117.0	3.7	137.0	51.0	257.3	44.6	224.4
Sonora	Nácori Chico	24.9	1.5	172.6	827.7	200.8	104.2	775.7
Sonora	Nacozari de García	104.6	7.6	236.6	111.1	672.1	113.6	305.1
Sonora	Navojoa	465.5	88.2	2,777.8	7,852.9	7,953.3	2,075.1	3,293.7
Sonora	Nogales	647.0	110.3	4,106.7	1,949.4	7,815.8	1,407.2	671.7
Sonora	Onavas	0.8	0.1	10.1	18.9	24.5	5.7	153.1
Sonora	Opodepe	72.6	1.0	54.7	96.8	152.7	33.9	663.8
Sonora	Oquitoa	0.5	0.0	7.2	20.7	22.5	5.3	140.2
Sonora	Pitiquito	107.5	3.6	141.8	228.5	473.6	94.5	975.4
Sonora	Puerto Peñasco	368.8	32.3	481.4	199.7	1,027.3	180.3	231.4

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Sonora	Quiriego	6.4	0.6	91.9	254.0	199.7	58.6	886.2
Sonora	Rayón	2.2	0.4	26.5	65.6	89.1	20.2	398.5
Sonora	Rosario	9.4	1.3	127.2	301.6	288.9	77.0	784.7
Sonora	Sahuaripa	9.1	1.7	106.0	183.9	320.1	68.4	1,459.3
Sonora	San Felipe de Jesús	0.5	0.0	5.8	4.1	21.3	3.7	47.0
Sonora	San Javier	0.4	0.1	9.8	10.3	14.1	3.2	145.9
Sonora	San Luis Río Colorado	612.3	85.3	2,614.1	4,380.5	7,625.5	1,547.6	517.2
Sonora	San Miguel de Horcasitas	47.3	2.5	85.6	189.9	287.8	63.5	517.3
Sonora	San Pedro de la Cueva	2.5	0.3	27.9	34.9	81.2	16.0	509.7
Sonora	Santa Ana	103.9	7.4	283.3	130.0	642.2	111.6	509.8
Sonora	Santa Cruz	131.0	1.5	26.3	49.4	86.2	19.4	302.1
Sonora	Sáric	2.7	0.3	31.7	51.6	111.3	22.2	386.4
Sonora	Soyopa	3.7	0.2	34.2	84.4	86.3	21.6	389.8
Sonora	Suaqui Grande	1.5	0.2	15.1	21.1	59.0	11.2	282.9
Sonora	Tepache	1.8	0.3	19.8	16.4	71.4	12.6	259.3
Sonora	Trincheras	136.3	1.6	38.8	149.9	108.3	32.2	557.9
Sonora	Tubutama	2.3	0.2	32.4	67.7	93.1	21.0	311.5
Sonora	Ures	11.5	1.8	127.5	168.0	478.6	89.7	1,089.3
Sonora	Villa Hidalgo	8.1	0.3	60.2	227.7	119.3	38.2	363.2
Sonora	Villa Pesqueira	2.1	0.2	27.0	27.3	76.4	14.5	564.8
Sonora	Yécora	17.7	1.8	186.7	584.7	340.6	110.1	984.8
Sonora	General Plutarco Elías Calles	15.0	7.7	143.6	103.0	548.9	92.5	347.5
Sonora	Benito Juárez	24.7	6.6	439.2	2,596.8	1,400.5	448.5	39.0
Sonora	San Ignacio Río Muerto	14.7	2.8	274.0	1,645.1	909.1	289.4	170.8
Total - State		***10,120.5***	***1,557.2***	***41,728.8***	***65,671.4***	***96,766.5***	***22,226.0***	***49,002.1***
Tamaulipas	Abasolo	15.0	5.1	575.9	157.1	745.1	142.9	727.5
Tamaulipas	Aldama	35.7	9.3	473.3	869.7	1,156.4	275.8	6,450.9
Tamaulipas	Altamira	1,910.4	94.8	1,900.0	1,535.9	4,942.9	1,098.7	1,977.3
Tamaulipas	Antiguo Morelos	14.3	2.3	252.0	973.9	526.0	166.6	243.8
Tamaulipas	Burgos	5.1	0.9	82.2	170.7	299.9	64.6	1,198.4
Tamaulipas	Bustamante	10.8	1.1	172.5	468.3	469.7	126.9	351.9
Tamaulipas	Camargo	138.4	7.6	430.0	156.9	833.1	143.2	277.2
Tamaulipas	Casas	56.2	1.0	132.5	267.8	367.2	92.9	962.1
Tamaulipas	Ciudad Madero	229.5	136.2	2,867.4	902.1	6,280.4	1,257.9	203.6
Tamaulipas	Cruillas	2.2	0.2	35.6	33.0	134.6	25.4	466.9
Tamaulipas	Gómez Farías	11.5	2.0	254.3	1,109.8	568.4	178.2	157.5
Tamaulipas	González	217.1	17.0	778.1	1,553.1	1,785.8	457.4	2,168.8
Tamaulipas	Güémez	30.3	2.3	265.4	554.6	776.9	182.2	530.8
Tamaulipas	Guerrero	4.8	1.8	60.7	22.1	217.0	35.3	892.2
Tamaulipas	Gustavo Díaz Ordaz	72.5	7.5	333.3	87.6	830.1	140.3	147.9
Tamaulipas	Hidalgo	134.4	7.4	452.0	864.4	1,357.2	309.7	832.5
Tamaulipas	Jaumave	22.4	3.3	296.3	718.4	727.3	191.3	533.6
Tamaulipas	Jiménez	10.1	2.5	126.5	142.5	473.4	91.3	625.6
Tamaulipas	Llera	118.4	4.1	362.4	839.5	978.1	245.8	831.8
Tamaulipas	Mainero	3.7	0.4	55.6	127.2	164.7	40.4	179.6
Tamaulipas	El Mante	446.9	71.9	1,790.3	3,021.9	5,762.0	1,411.8	1,014.6
Tamaulipas	Matamoros	1,053.7	280.2	8,428.2	2,890.8	15,087.0	3,032.4	1,465.1
Tamaulipas	Méndez	4.9	0.6	138.0	52.7	513.0	101.6	673.0
Tamaulipas	Mier	8.7	4.3	91.6	126.8	324.2	53.0	451.8
Tamaulipas	Miguel Alemán	38.1	20.5	341.4	113.6	862.1	148.2	268.5
Tamaulipas	Miquihuana	9.1	0.7	105.0	354.3	219.7	70.5	215.9
Tamaulipas	Nuevo Laredo	677.3	246.4	6,647.6	2,682.0	11,010.9	2,172.8	673.3
Tamaulipas	Nuevo Morelos	4.3	0.6	95.5	458.7	204.6	68.9	145.4
Tamaulipas	Ocampo	20.0	3.4	381.7	1,410.6	864.2	262.2	670.1
Tamaulipas	Padilla	14.6	3.7	211.4	276.6	718.8	144.6	366.5
Tamaulipas	Palmillas	4.4	0.6	48.2	93.1	106.8	26.9	119.6
Tamaulipas	Reynosa	1,091.3	322.9	8,024.2	4,438.0	14,667.3	2,946.7	1,090.1
Tamaulipas	Río Bravo	188.9	62.0	1,800.7	648.3	5,304.2	996.1	336.8
Tamaulipas	San Carlos	12.1	1.1	194.5	418.4	594.9	142.3	824.1
Tamaulipas	San Fernando	65.1	18.4	972.7	438.4	2,908.6	569.7	1,289.1
Tamaulipas	San Nicolás	1.4	0.1	20.8	58.4	56.2	14.9	86.4
Tamaulipas	Soto la Marina	27.2	7.3	370.7	536.7	1,289.9	258.1	4,583.6
Tamaulipas	Tampico	3,287.4	401.8	3,390.8	1,652.5	10,222.9	2,082.7	288.1
Tamaulipas	Tula	36.8	7.5	525.1	1,231.3	1,102.1	312.0	859.8
Tamaulipas	Valle Hermoso	100.1	36.3	1,241.2	267.6	2,177.5	387.5	254.3
Tamaulipas	Victoria	450.8	295.2	3,444.1	2,137.2	9,373.3	2,027.4	769.6
Tamaulipas	Villagrán	106.2	1.9	139.6	295.1	409.3	98.8	789.3
Tamaulipas	Xicoténcatl	354.0	8.0	542.4	1,881.5	1,557.8	595.2	305.7
Total - State		***11,046.2***	***2,102.4***	***48,851.4***	***37,039.1***	***108,971.3***	***23,191.1***	***37,300.5***
Total - Six States		***62,802.8***	***58,856.6***	***323,710.8***	***232,586.7***	***746,993.8***	***156,867.9***	***187,435.6***

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Baja California	Ensenada	1,344.2	78.7	1,620.9	12,452.5	41.1	33.7	34.5
Baja California	Mexicali	3,630.4	206.8	4,324.2	33,543.7	107.9	88.4	71.2
Baja California	Tecate	150.5	8.2	188.2	1,408.3	4.3	3.5	2.2
Baja California	Tijuana	7,992.1	451.4	9,766.3	74,512.1	235.9	193.2	134.4
Baja California	Playas de Rosarito	121.3	6.6	153.7	1,139.7	3.4	2.8	1.8
Total - State		***13,238.6***	***751.8***	***16,053.3***	***123,056.3***	***392.7***	***321.6***	***244.1***
Coahuila	Abasolo	2.3	0.1	2.7	21.4	0.1	0.1	0.0
Coahuila	Acuña	507.6	29.7	619.4	4,718.5	15.5	12.7	8.5
Coahuila	Allende	43.4	2.5	50.1	397.4	1.3	1.1	0.6
Coahuila	Arteaga	62.2	3.6	76.7	728.3	1.9	1.5	1.8
Coahuila	Candela	3.5	0.2	4.0	31.8	0.1	0.1	0.0
Coahuila	Castaños	46.7	2.7	53.9	427.5	1.4	1.2	0.6
Coahuila	Cuatrociénegas	25.2	1.5	29.1	230.6	0.8	0.6	0.3
Coahuila	Escobedo	5.8	0.3	6.7	52.8	0.2	0.1	0.1
Coahuila	Francisco I. Madero	90.9	5.0	112.2	847.3	2.6	2.2	1.3
Coahuila	Frontera	372.1	21.1	444.8	3,441.9	11.0	9.0	6.2
Coahuila	General Cepeda	23.3	1.4	28.2	270.1	0.7	0.6	0.3
Coahuila	Guerrero	4.3	0.2	4.9	38.9	0.1	0.1	0.1
Coahuila	Hidalgo	3.0	0.2	3.4	27.3	0.1	0.1	0.0
Coahuila	Jiménez	20.2	1.2	23.3	184.5	0.6	0.5	0.3
Coahuila	Juárez	3.3	0.2	3.9	30.5	0.1	0.1	0.0
Coahuila	Lamadrid	3.7	0.2	4.3	33.8	0.1	0.1	0.1
Coahuila	Matamoros	181.7	10.2	222.0	1,689.2	5.3	4.4	2.6
Coahuila	Monclova	1,117.9	63.4	1,337.1	10,342.1	33.1	27.1	18.0
Coahuila	Morelos	15.1	0.9	17.4	137.8	0.5	0.4	0.2
Coahuila	Múzquiz	123.5	6.9	151.5	1,149.5	3.6	3.0	1.8
Coahuila	Nadadores	12.3	0.7	14.2	112.8	0.4	0.3	0.2
Coahuila	Nava	47.7	2.8	55.1	436.8	1.5	1.2	0.7
Coahuila	Ocampo	25.0	1.5	28.9	228.7	0.8	0.6	0.3
Coahuila	Parras	82.8	4.6	108.7	998.9	2.4	2.0	1.2
Coahuila	Piedras Negras	591.1	34.6	721.5	5,495.2	18.1	14.8	9.9
Coahuila	Progreso	7.5	0.4	8.6	68.5	0.2	0.2	0.1
Coahuila	Ramos Arizpe	197.6	11.3	246.7	2,329.5	5.9	4.8	3.7
Coahuila	Sabinas	98.8	5.3	127.2	932.3	2.8	2.3	1.5
Coahuila	Sacramento	4.2	0.2	4.8	38.1	0.1	0.1	0.1
Coahuila	Saltillo	3,265.1	186.7	4,087.6	38,553.6	97.4	79.8	53.8
Coahuila	San Buenaventura	41.6	2.4	48.0	380.4	1.3	1.0	0.6
Coahuila	San Juan de Sabinas	75.6	4.0	97.5	713.7	2.1	1.7	1.1
Coahuila	San Pedro	174.6	9.8	213.1	1,622.3	5.1	4.2	2.5
Coahuila	Sierra Mojada	12.4	0.7	14.7	126.5	0.4	0.3	0.2
Coahuila	Torreón	2,968.5	168.5	3,548.7	27,459.1	87.9	72.0	49.3
Coahuila	Viesca	39.3	2.3	45.4	359.9	1.2	1.0	0.5
Coahuila	Villa Unión	12.8	0.7	14.7	116.9	0.4	0.3	0.2
Coahuila	Zaragoza	26.3	1.5	30.3	240.3	0.8	0.7	0.4
Total - State		***10,338.6***	***589.9***	***12,611.0***	***105,014.5***	***307.9***	***252.2***	***169.3***
Chihuahua	Ahumada	24.7	1.4	28.5	225.8	0.8	0.6	0.3
Chihuahua	Aldama	40.2	2.4	46.4	367.7	1.2	1.0	0.6
Chihuahua	Allende	17.6	1.0	21.3	204.3	0.5	0.4	0.2
Chihuahua	Aquiles Serdán	11.0	0.6	13.3	127.1	0.3	0.3	0.2
Chihuahua	Ascensión	45.5	2.7	52.5	416.3	1.4	1.1	0.6
Chihuahua	Bachíniva	13.2	0.8	15.9	152.8	0.4	0.3	0.2
Chihuahua	Balleza	34.5	2.0	41.7	400.2	1.1	0.9	0.5
Chihuahua	Batopilas	26.0	1.5	30.0	238.0	0.8	0.7	0.4
Chihuahua	Bocoyna	57.4	3.4	69.4	666.0	1.8	1.5	0.8
Chihuahua	Buenaventura	41.3	2.4	49.9	478.6	1.3	1.0	0.6
Chihuahua	Camargo	87.3	4.7	111.2	821.5	2.5	2.0	1.3
Chihuahua	Carichí	16.0	0.9	19.3	185.2	0.5	0.4	0.2
Chihuahua	Casas Grandes	20.6	1.2	24.9	238.7	0.6	0.5	0.3
Chihuahua	Coronado	4.5	0.3	5.5	52.6	0.1	0.1	0.1
Chihuahua	Coyame del Sotol	3.5	0.2	4.1	32.4	0.1	0.1	0.0
Chihuahua	La Cruz	7.8	0.5	9.4	90.1	0.2	0.2	0.1
Chihuahua	Cuauhtémoc	238.3	13.2	311.9	2,871.0	6.9	5.6	9.6
Chihuahua	Cusihuiriachi	11.9	0.7	14.4	138.0	0.4	0.3	0.2
Chihuahua	Chihuahua	3,809.6	217.9	4,769.5	44,984.3	113.7	93.1	62.5
Chihuahua	Chínipas	14.0	0.8	16.2	128.4	0.4	0.4	0.2
Chihuahua	Delicias	221.0	11.9	282.4	2,081.4	6.2	5.1	9.0
Chihuahua	Dr. Belisario Domínguez	7.9	0.5	9.6	92.0	0.2	0.2	0.1
Chihuahua	Galeana	8.0	0.5	9.6	92.5	0.2	0.2	0.1
Chihuahua	Santa Isabel	9.8	0.6	11.8	113.6	0.3	0.2	0.1
Chihuahua	Gómez Farías	18.2	1.1	22.1	211.6	0.6	0.5	0.3
Chihuahua	Gran Morelos	8.0	0.5	9.6	92.5	0.2	0.2	0.1

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Chihuahua	Guachochi	84.2	4.9	97.2	770.6	2.6	2.1	1.2
Chihuahua	Guadalupe	20.8	1.2	24.0	190.3	0.6	0.5	0.3
Chihuahua	Guadalupe y Calvo	99.5	5.9	120.3	1,154.0	3.1	2.5	1.4
Chihuahua	Guazapares	16.6	1.0	20.1	192.5	0.5	0.4	0.2
Chihuahua	Guerrero	80.5	4.8	97.3	933.3	2.5	2.0	1.1
Chihuahua	Hidalgo del Parral	187.1	10.0	253.6	2,293.4	5.2	4.3	7.8
Chihuahua	Hejotitán	2.4	0.1	2.9	27.9	0.1	0.1	0.0
Chihuahua	Ignacio Zaragoza	16.1	1.0	19.5	186.9	0.5	0.4	0.2
Chihuahua	Janos	21.2	1.2	24.5	193.8	0.7	0.5	0.3
Chihuahua	Jiménez	73.0	3.9	92.9	686.8	2.1	1.7	1.1
Chihuahua	Juárez	8,192.9	462.6	10,016.2	76,395.5	241.7	198.0	135.3
Chihuahua	Julimes	10.7	0.6	12.4	98.0	0.3	0.3	0.1
Chihuahua	López	8.4	0.5	10.2	97.4	0.3	0.2	0.1
Chihuahua	Madera	70.1	4.1	84.7	812.7	2.2	1.8	1.0
Chihuahua	Maguarichi	3.7	0.2	4.5	42.8	0.1	0.1	0.1
Chihuahua	Manuel Benavides	3.6	0.2	4.2	33.1	0.1	0.1	0.1
Chihuahua	Matachí	6.6	0.4	8.0	76.9	0.2	0.2	0.1
Chihuahua	Matamoros	9.1	0.5	11.0	105.7	0.3	0.2	0.1
Chihuahua	Meoqui	83.0	4.9	95.8	759.3	2.5	2.1	1.1
Chihuahua	Morelos	19.7	1.2	22.7	179.9	0.6	0.5	0.3
Chihuahua	Moris	10.8	0.6	12.5	99.0	0.3	0.3	0.1
Chihuahua	Namiquipa	48.6	2.9	58.8	564.2	1.5	1.2	0.7
Chihuahua	Nonoava	6.1	0.4	7.3	70.3	0.2	0.2	0.1
Chihuahua	Nuevo Casas Grandes	101.5	5.4	136.7	1,240.6	2.9	2.3	1.6
Chihuahua	Ocampo	15.0	0.9	18.1	173.6	0.5	0.4	0.2
Chihuahua	Ojinaga	50.4	3.0	58.2	461.2	1.5	1.3	0.7
Chihuahua	Praxedis G. Guerrero	18.5	1.1	21.3	169.0	0.6	0.5	0.3
Chihuahua	Riva Palacio	20.6	1.2	24.9	239.1	0.6	0.5	0.3
Chihuahua	Rosales	31.0	1.8	35.8	284.0	1.0	0.8	0.4
Chihuahua	Rosario	5.3	0.3	6.4	61.5	0.2	0.1	0.1
Chihuahua	San Francisco de Borja	4.8	0.3	5.8	55.6	0.1	0.1	0.1
Chihuahua	San Francisco de Conchos	5.9	0.3	6.8	53.9	0.2	0.1	0.1
Chihuahua	San Francisco del Oro	12.5	0.7	15.1	144.5	0.4	0.3	0.2
Chihuahua	Santa Bárbara	23.9	1.4	28.9	276.8	0.7	0.6	0.3
Chihuahua	Satevó	10.3	0.6	11.9	94.2	0.3	0.3	0.1
Chihuahua	Saucillo	63.5	3.7	73.4	581.4	2.0	1.6	0.9
Chihuahua	Temósachi	14.4	0.9	17.4	166.8	0.4	0.4	0.2
Chihuahua	El Tule	4.5	0.3	5.4	52.0	0.1	0.1	0.1
Chihuahua	Urique	36.6	2.1	42.3	335.0	1.1	0.9	0.5
Chihuahua	Uruachi	17.2	1.0	19.8	157.1	0.5	0.4	0.2
Chihuahua	Valle de Zaragoza	11.0	0.6	12.7	100.7	0.3	0.3	0.2
Total - State		***14,319.1***	***812.6***	***17,642.2***	***146,114.3***	***424.5***	***347.7***	***247.6***
Nuevo Leon	Abasolo	5.2	0.3	6.0	47.7	0.2	0.1	0.1
Nuevo Leon	Agualeguas	9.1	0.5	10.5	83.3	0.3	0.2	0.1
Nuevo Leon	Los Aldamas	5.1	0.3	5.9	46.8	0.2	0.1	0.1
Nuevo Leon	Allende	57.6	3.4	66.5	527.0	1.8	1.4	0.8
Nuevo Leon	Anáhuac	38.4	2.3	44.3	351.5	1.2	1.0	0.5
Nuevo Leon	Apodaca	3,036.7	161.1	3,954.3	29,454.2	84.1	68.9	47.7
Nuevo Leon	Aramberri	30.7	1.8	35.8	295.2	0.9	0.8	0.4
Nuevo Leon	Bustamante	7.3	0.4	8.4	66.4	0.2	0.2	0.1
Nuevo Leon	Cadereyta Jiménez	143.8	7.8	184.1	1,357.4	4.1	3.4	2.2
Nuevo Leon	Carmen	13.8	0.8	15.9	126.1	0.4	0.3	0.2
Nuevo Leon	Cerralvo	19.4	1.1	22.4	177.3	0.6	0.5	0.3
Nuevo Leon	Ciénega de Flores	23.2	1.4	26.8	212.6	0.7	0.6	0.3
Nuevo Leon	China	23.9	1.4	27.9	219.6	0.7	0.6	0.3
Nuevo Leon	Doctor Arroyo	69.4	4.1	83.9	804.7	2.1	1.8	1.0
Nuevo Leon	Doctor Coss	4.7	0.3	5.4	42.6	0.1	0.1	0.1
Nuevo Leon	Doctor González	6.6	0.4	7.6	60.4	0.2	0.2	0.1
Nuevo Leon	Galeana	81.3	4.8	98.3	943.1	2.5	2.1	1.1
Nuevo Leon	García	287.0	15.3	373.0	2,781.1	8.0	6.5	4.9
Nuevo Leon	San Pedro Garza García	1,401.9	74.3	1,827.5	13,605.1	38.8	31.8	21.2
Nuevo Leon	General Bravo	12.0	0.7	13.9	110.0	0.4	0.3	0.2
Nuevo Leon	General Escobedo	2,572.3	136.4	3,352.2	24,959.5	71.2	58.3	39.3
Nuevo Leon	General Terán	32.1	1.9	37.0	293.6	1.0	0.8	0.4
Nuevo Leon	General Treviño	3.5	0.2	4.1	32.2	0.1	0.1	0.0
Nuevo Leon	General Zaragoza	11.6	0.7	13.3	105.8	0.4	0.3	0.2
Nuevo Leon	General Zuazua	12.4	0.7	15.1	116.0	0.4	0.3	0.2
Nuevo Leon	Guadalupe	7,456.6	395.2	9,719.8	72,361.9	206.4	169.1	112.8
Nuevo Leon	Los Herreras	5.8	0.3	6.7	53.0	0.2	0.1	0.1
Nuevo Leon	Higueras	2.8	0.2	3.3	26.0	0.1	0.1	0.0
Nuevo Leon	Hualahuises	13.3	0.8	15.4	121.7	0.4	0.3	0.2

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Nuevo Leon	Iurbide	7.2	0.4	8.7	83.1	0.2	0.2	0.1
Nuevo Leon	Juárez	257.7	14.3	319.5	2,439.8	7.5	6.1	11.2
Nuevo Leon	Lampazos de Naranjo	11.0	0.6	12.7	100.7	0.3	0.3	0.2
Nuevo Leon	Linares	132.4	7.2	167.7	1,243.6	3.8	3.1	2.0
Nuevo Leon	Marín	9.8	0.6	11.3	89.5	0.3	0.2	0.1
Nuevo Leon	Melchor Ocampo	2.5	0.1	2.9	23.1	0.1	0.1	0.0
Nuevo Leon	Mier y Noriega	14.6	0.9	17.6	168.9	0.5	0.4	0.2
Nuevo Leon	Mina	10.5	0.6	12.1	95.8	0.3	0.3	0.1
Nuevo Leon	Montemorelos	101.6	5.5	127.7	951.9	2.9	2.4	1.5
Nuevo Leon	Monterrey	12,365.5	655.4	16,118.9	120,001.2	342.3	280.3	187.0
Nuevo Leon	Parás	2.5	0.1	2.9	23.3	0.1	0.1	0.0
Nuevo Leon	Pesquería	23.5	1.4	27.1	214.8	0.7	0.6	0.3
Nuevo Leon	Los Ramones	12.9	0.8	14.9	118.3	0.4	0.3	0.2
Nuevo Leon	Rayones	5.4	0.3	6.3	49.6	0.2	0.1	0.1
Nuevo Leon	Sabinas Hidalgo	60.6	3.2	78.6	573.4	1.7	1.4	0.9
Nuevo Leon	Salinas Victoria	39.4	2.3	45.5	361.0	1.2	1.0	0.5
Nuevo Leon	San Nicolás de los Garza	5,530.7	293.2	7,209.4	53,672.4	153.1	125.4	83.6
Nuevo Leon	Hidalgo	29.6	1.7	34.2	270.9	0.9	0.7	0.4
Nuevo Leon	Santa Catarina	2,517.5	133.5	3,281.3	24,429.7	69.7	57.1	38.2
Nuevo Leon	Santiago	69.4	3.7	89.4	655.3	1.9	1.6	1.1
Nuevo Leon	Vallecillo	4.5	0.3	5.2	41.2	0.1	0.1	0.1
Nuevo Leon	Villaldama	8.8	0.5	10.2	80.6	0.3	0.2	0.1
Total - State		***36,605.1***	***1,945.6***	***47,589.3***	***355,070.0***	***1,016.1***	***832.3***	***562.8***
Sonora	Aconchi	5.0	0.3	5.8	45.9	0.2	0.1	0.1
Sonora	Agua Prieta	115.9	6.1	150.6	1,097.1	3.2	2.6	1.8
Sonora	Alamos	52.1	3.1	60.2	477.2	1.6	1.3	0.7
Sonora	Altar	15.0	0.9	17.5	138.0	0.5	0.4	0.2
Sonora	Arivechi	3.1	0.2	3.6	28.2	0.1	0.1	0.0
Sonora	Arizpe	7.0	0.4	8.1	64.4	0.2	0.2	0.1
Sonora	Atil	1.5	0.1	1.7	13.6	0.0	0.0	0.0
Sonora	Bacadéhuachi	2.8	0.2	3.2	25.6	0.1	0.1	0.0
Sonora	Bacanora	2.0	0.1	2.3	17.9	0.1	0.0	0.0
Sonora	Bacerac	2.8	0.2	3.3	25.9	0.1	0.1	0.0
Sonora	Bacoachi	3.1	0.2	3.6	28.4	0.1	0.1	0.0
Sonora	Bácum	44.2	2.6	51.0	404.6	1.4	1.1	0.6
Sonora	Banámichi	3.1	0.2	3.6	28.2	0.1	0.1	0.0
Sonora	Baviácora	7.7	0.5	8.9	70.7	0.2	0.2	0.1
Sonora	Bavispe	2.9	0.2	3.3	26.1	0.1	0.1	0.0
Sonora	Benjamín Hill	11.9	0.7	13.7	108.8	0.4	0.3	0.2
Sonora	Caborca	133.8	7.3	168.3	1,254.4	3.8	3.1	2.0
Sonora	Cajeme	1,377.9	80.3	1,677.1	12,798.3	41.9	34.4	33.2
Sonora	Cananea	59.7	3.2	80.6	730.4	1.7	1.4	0.9
Sonora	Carbó	10.3	0.6	11.9	94.6	0.3	0.3	0.1
Sonora	La Colorada	4.8	0.3	5.5	43.8	0.1	0.1	0.1
Sonora	Cucurpe	1.9	0.1	2.2	17.8	0.1	0.0	0.0
Sonora	Cumpas	12.9	0.8	14.8	117.7	0.4	0.3	0.2
Sonora	Divisaderos	1.7	0.1	2.0	15.7	0.1	0.0	0.0
Sonora	Empalme	95.5	5.2	122.5	901.5	2.7	2.2	1.4
Sonora	Etchojoa	116.4	6.8	134.4	1,065.0	3.6	2.9	1.6
Sonora	Fronteras	16.2	0.9	18.7	148.0	0.5	0.4	0.2
Sonora	Granados	2.6	0.2	3.0	23.4	0.1	0.1	0.0
Sonora	Guaymas	250.1	13.6	315.7	2,346.6	7.1	5.8	10.0
Sonora	Hermosillo	3,294.9	187.2	3,935.8	30,470.5	97.7	80.0	56.8
Sonora	Huachinera	2.4	0.1	2.7	21.8	0.1	0.1	0.0
Sonora	Huásabas	2.0	0.1	2.3	18.3	0.1	0.1	0.0
Sonora	Huatabampo	152.0	8.6	183.8	1,409.1	4.5	3.7	2.2
Sonora	Huépac	2.4	0.1	2.7	21.7	0.1	0.1	0.0
Sonora	Imuris	20.7	1.2	23.9	189.5	0.6	0.5	0.3
Sonora	Magdalena	50.7	3.0	58.5	463.9	1.6	1.3	0.7
Sonora	Mazatán	3.3	0.2	3.8	30.1	0.1	0.1	0.0
Sonora	Moctezuma	8.7	0.5	10.0	79.4	0.3	0.2	0.1
Sonora	Naco	11.0	0.7	13.4	128.2	0.3	0.3	0.2
Sonora	Nácori Chico	4.6	0.3	5.4	42.4	0.1	0.1	0.1
Sonora	Nacozari de García	29.8	1.7	34.4	272.6	0.9	0.7	0.4
Sonora	Navojoa	271.3	14.8	340.4	2,541.6	7.8	6.4	10.8
Sonora	Nogales	735.2	43.0	897.2	6,834.5	22.5	18.4	12.3
Sonora	Onavas	1.0	0.1	1.1	9.1	0.0	0.0	0.0
Sonora	Opodepe	5.9	0.3	6.8	53.7	0.2	0.1	0.1
Sonora	Oquitoa	0.8	0.0	1.0	7.6	0.0	0.0	0.0
Sonora	Pitiquito	19.1	1.1	22.1	175.2	0.6	0.5	0.3
Sonora	Puerto Peñasco	58.3	3.1	75.7	551.7	1.6	1.3	0.9

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$	NH_3
Sonora	Quiriego	6.9	0.4	8.0	63.3	0.2	0.2	0.1
Sonora	Rayón	3.3	0.2	3.8	30.2	0.1	0.1	0.0
Sonora	Rosario	11.3	0.7	13.0	103.1	0.3	0.3	0.2
Sonora	Sahuaripa	13.3	0.8	15.3	121.4	0.4	0.3	0.2
Sonora	San Felipe de Jesús	0.9	0.1	1.0	7.9	0.0	0.0	0.0
Sonora	San Javier	0.6	0.0	0.7	5.3	0.0	0.0	0.0
Sonora	San Luis Río Colorado	626.8	36.7	762.7	5,821.6	19.2	15.7	11.2
Sonora	San Miguel de Horcasitas	11.7	0.7	13.5	106.7	0.4	0.3	0.2
Sonora	San Pedro de la Cueva	3.5	0.2	4.1	32.3	0.1	0.1	0.0
Sonora	Santa Ana	28.0	1.6	32.4	256.6	0.9	0.7	0.4
Sonora	Santa Cruz	3.4	0.2	3.9	30.9	0.1	0.1	0.0
Sonora	Sáric	4.7	0.3	5.4	42.8	0.1	0.1	0.1
Sonora	Soyopa	3.4	0.2	3.9	31.3	0.1	0.1	0.0
Sonora	Suaqui Grande	2.4	0.1	2.8	22.3	0.1	0.1	0.0
Sonora	Tepache	3.2	0.2	3.7	29.2	0.1	0.1	0.0
Sonora	Trincheras	3.6	0.2	4.2	33.3	0.1	0.1	0.1
Sonora	Tubutama	3.7	0.2	4.3	34.1	0.1	0.1	0.1
Sonora	Ures	19.8	1.2	22.9	181.5	0.6	0.5	0.3
Sonora	Villa Hidalgo	4.1	0.2	4.8	37.7	0.1	0.1	0.1
Sonora	Villa Pesqueira	3.3	0.2	3.8	30.2	0.1	0.1	0.0
Sonora	Yécora	12.5	0.7	15.1	144.8	0.4	0.3	0.2
Sonora	General Plutarco Elías Calles	23.4	1.4	27.0	214.0	0.7	0.6	0.3
Sonora	Benito Juárez	45.2	2.7	52.2	413.9	1.4	1.1	0.6
Sonora	San Ignacio Río Muerto	28.4	1.7	32.8	259.8	0.9	0.7	0.4
Total - State		***7,905.5***	***452.2***	***9,559.4***	***73,532.7***	***236.2***	***193.5***	***153.6***
Tamaulipas	Abasolo	27.6	1.6	31.9	252.5	0.8	0.7	0.4
Tamaulipas	Aldama	58.0	3.4	67.0	531.2	1.8	1.5	0.8
Tamaulipas	Altamira	407.8	22.8	497.0	3,791.2	11.9	9.8	11.9
Tamaulipas	Antiguo Morelos	18.5	1.1	21.3	169.2	0.6	0.5	0.3
Tamaulipas	Burgos	10.7	0.6	12.4	98.3	0.3	0.3	0.1
Tamaulipas	Bustamante	15.5	0.9	18.7	179.5	0.5	0.4	0.2
Tamaulipas	Camargo	34.8	2.0	40.2	318.5	1.1	0.9	0.5
Tamaulipas	Casas	9.4	0.6	10.9	86.1	0.3	0.2	0.1
Tamaulipas	Ciudad Madero	1,056.1	59.9	1,263.4	9,771.4	31.3	25.6	17.0
Tamaulipas	Cruillas	4.8	0.3	5.6	44.3	0.1	0.1	0.1
Tamaulipas	Gómez Farías	17.8	1.0	20.5	162.6	0.5	0.4	0.2
Tamaulipas	González	86.0	5.0	99.2	786.6	2.6	2.2	1.2
Tamaulipas	Güémez	30.1	1.8	34.7	275.1	0.9	0.8	0.4
Tamaulipas	Guerrero	9.1	0.5	10.5	82.8	0.3	0.2	0.1
Tamaulipas	Gustavo Díaz Ordaz	33.7	2.0	38.9	308.3	1.0	0.8	0.5
Tamaulipas	Hidalgo	50.3	3.0	58.1	460.7	1.5	1.3	0.7
Tamaulipas	Jaumave	27.3	1.6	31.6	250.2	0.8	0.7	0.4
Tamaulipas	Jiménez	17.6	1.0	20.4	161.5	0.5	0.4	0.2
Tamaulipas	Llera	36.5	2.1	42.2	334.3	1.1	0.9	0.5
Tamaulipas	Mainero	5.9	0.3	6.8	53.7	0.2	0.1	0.1
Tamaulipas	El Mante	216.8	11.8	272.6	2,032.3	6.2	5.1	8.7
Tamaulipas	Matamoros	2,266.4	128.7	2,707.5	20,960.3	67.2	55.0	38.9
Tamaulipas	Méndez	11.1	0.6	12.8	101.3	0.3	0.3	0.2
Tamaulipas	Mier	14.1	0.8	16.3	128.8	0.4	0.4	0.2
Tamaulipas	Miguel Alemán	53.3	3.1	61.5	487.7	1.6	1.3	0.7
Tamaulipas	Miquihuana	6.5	0.4	7.9	75.8	0.2	0.2	0.1
Tamaulipas	Nuevo Laredo	1,793.3	101.7	2,144.9	16,590.7	53.1	43.5	28.9
Tamaulipas	Nuevo Morelos	6.4	0.4	7.3	58.2	0.2	0.2	0.1
Tamaulipas	Ocampo	27.6	1.6	31.8	252.4	0.8	0.7	0.4
Tamaulipas	Padilla	28.4	1.7	32.7	259.5	0.9	0.7	0.4
Tamaulipas	Palmillas	3.8	0.2	4.4	34.6	0.1	0.1	0.1
Tamaulipas	Reynosa	2,373.3	134.7	2,837.5	21,954.2	70.3	57.6	39.1
Tamaulipas	Río Bravo	199.5	10.8	252.5	1,873.9	5.7	4.6	8.0
Tamaulipas	San Carlos	19.9	1.2	22.9	181.7	0.6	0.5	0.3
Tamaulipas	San Fernando	113.4	6.4	138.5	1,054.3	3.3	2.7	1.6
Tamaulipas	San Nicolás	2.2	0.1	2.5	20.0	0.1	0.1	0.0
Tamaulipas	Soto la Marina	50.2	2.9	58.0	459.8	1.5	1.3	0.7
Tamaulipas	Tampico	1,711.4	97.1	2,047.2	15,833.7	50.6	41.5	27.5
Tamaulipas	Tula	56.1	3.3	64.8	513.2	1.7	1.4	0.8
Tamaulipas	Valle Hermoso	112.6	6.1	141.8	1,055.7	3.2	2.6	1.7
Tamaulipas	Victoria	1,186.8	69.5	1,446.9	11,028.7	36.3	29.7	24.5
Tamaulipas	Villagrán	14.5	0.9	16.8	132.9	0.4	0.4	0.2
Tamaulipas	Xicoténcatl	46.6	2.7	53.8	426.2	1.4	1.2	0.6
Total - State		***12,271.6***	***698.5***	***14,714.2***	***113,633.7***	***364.6***	***298.7***	***219.4***
Total - Six States		***94,678.5***	***5,250.6***	***118,169.4***	***916,421.5***	***2,742.1***	***2,246.0***	***1,596.9***

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Baja California	Ensenada	819.9	110.8	242.4	844.4	124.1	114.2
Baja California	Mexicali	2,063.6	275.6	562.9	1,992.1	325.7	299.6
Baja California	Tecate	98.8	13.7	34.5	116.5	13.5	12.4
Baja California	Tijuana	126.4	17.5	43.2	146.5	17.5	16.1
Baja California	Playas de Rosarito	1,920.7	266.4	663.8	2,248.4	263.9	242.7
Total - State		***5,029.4***	***684.0***	***1,546.6***	***5,348.0***	***744.7***	***685.1***
Coahuila	Abasolo	65.9	8.6	13.7	51.7	11.6	10.7
Coahuila	Acuña	97.9	12.9	20.7	77.8	17.1	15.7
Coahuila	Allende	48.5	6.4	10.0	37.9	8.5	7.9
Coahuila	Arteaga	15.4	2.0	3.8	13.7	2.6	2.3
Coahuila	Candela	274.0	35.6	50.8	197.7	49.9	45.9
Coahuila	Castaños	333.5	43.1	57.3	228.0	62.0	57.1
Coahuila	Cuatrociénegas	21.8	3.0	7.4	25.1	3.0	2.8
Coahuila	Escobedo	16.6	2.3	5.6	19.0	2.3	2.1
Coahuila	Francisco I. Madero	39.2	5.4	12.8	43.7	5.6	5.2
Coahuila	Frontera	338.2	43.8	61.1	239.6	62.0	57.1
Coahuila	General Cepeda	76.4	10.4	23.0	79.9	11.5	10.5
Coahuila	Guerrero	157.1	20.3	28.0	110.4	28.9	26.6
Coahuila	Hidalgo	138.3	18.0	25.4	99.1	25.3	23.2
Coahuila	Jiménez	1,066.5	145.7	327.8	1,134.4	157.9	145.3
Coahuila	Juárez	9.6	1.3	3.1	10.6	1.4	1.3
Coahuila	Lamadrid	26.1	3.4	4.9	18.9	4.8	4.4
Coahuila	Matamoros	6.5	0.9	1.5	5.4	1.1	1.0
Coahuila	Monclova	758.7	99.3	154.7	586.9	134.3	123.5
Coahuila	Morelos	308.0	39.8	52.9	210.5	57.3	52.7
Coahuila	Múzquiz	188.2	25.7	57.4	198.8	28.0	25.8
Coahuila	Nadadores	60.5	7.8	11.0	43.0	11.1	10.2
Coahuila	Nava	8.4	1.1	1.9	7.0	1.4	1.3
Coahuila	Ocampo	21.9	2.9	4.5	17.1	3.8	3.5
Coahuila	Parras	283.9	36.7	49.5	196.2	52.6	48.4
Coahuila	Piedras Negras	151.1	19.5	26.2	103.9	28.0	25.8
Coahuila	Progreso	58.6	8.1	18.8	64.6	8.4	7.8
Coahuila	Ramos Arizpe	131.4	17.1	24.2	94.5	24.0	22.1
Coahuila	Sabinas	74.4	10.2	23.2	80.1	10.9	10.1
Coahuila	Sacramento	10.5	1.5	3.6	12.1	1.5	1.3
Coahuila	Saltillo	539.6	70.0	99.1	386.7	98.6	90.7
Coahuila	San Buenaventura	2.1	0.3	0.6	2.1	0.3	0.3
Coahuila	San Juan de Sabinas	141.2	19.4	46.0	157.6	20.2	18.6
Coahuila	San Pedro	311.8	40.3	54.0	214.3	57.9	53.2
Coahuila	Sierra Mojada	133.5	17.3	24.6	96.0	24.4	22.4
Coahuila	Torreón	132.5	17.5	30.7	112.8	22.4	20.6
Coahuila	Viesca	1,558.3	215.8	531.6	1,805.1	216.0	198.7
Coahuila	Villa Unión	48.1	6.3	9.2	35.5	8.7	8.0
Coahuila	Zaragoza	24.3	3.2	4.9	18.6	4.3	4.0
Total - State		***7,678.5***	***1,022.8***	***1,885.4***	***6,836.3***	***1,269.5***	***1,167.9***
Chihuahua	Ahumada	49.3	6.4	9.2	35.7	9.0	8.3
Chihuahua	Aldama	158.3	20.8	34.1	127.5	27.5	25.3
Chihuahua	Allende	2.2	0.3	0.8	2.6	0.3	0.3
Chihuahua	Aquiles Serdán	22.4	2.9	4.1	16.1	4.1	3.8
Chihuahua	Ascensión	131.3	17.0	22.7	90.2	24.4	22.4
Chihuahua	Bachíniva	35.8	4.7	7.0	26.8	6.4	5.9
Chihuahua	Balleza	184.6	24.3	39.8	148.9	32.1	29.5
Chihuahua	Batopilas	11.6	1.6	4.1	13.7	1.6	1.5
Chihuahua	Bocoyna	7.0	1.0	2.3	8.0	1.0	0.9
Chihuahua	Buenaventura	1,613.0	208.2	275.4	1,098.0	300.4	276.4
Chihuahua	Camargo	3.6	0.5	1.3	4.3	0.5	0.5
Chihuahua	Carichí	74.2	10.2	24.5	83.7	10.5	9.7
Chihuahua	Casas Grandes	11.4	1.6	3.5	12.2	1.7	1.6
Chihuahua	Coronado	149.5	19.6	30.4	115.5	26.5	24.4
Chihuahua	Coyame del Sotol	129.4	16.8	23.7	92.4	23.7	21.8
Chihuahua	La Cruz	97.8	12.7	18.6	71.9	17.7	16.3
Chihuahua	Cuauhtémoc	295.9	38.3	52.9	208.0	54.4	50.1
Chihuahua	Cusihuiriachi	9.5	1.3	2.2	8.0	1.6	1.5
Chihuahua	Chihuahua	21.9	2.8	4.2	16.1	3.9	3.6
Chihuahua	Chínipas	11.1	1.5	2.5	9.2	1.9	1.7
Chihuahua	Delicias	15.6	2.1	4.0	14.3	2.6	2.3
Chihuahua	Dr. Belisario Domínguez	39.5	5.2	9.2	33.8	6.7	6.1
Chihuahua	Galeana	259.3	33.5	44.5	177.1	48.2	44.4
Chihuahua	Santa Isabel	63.1	8.2	11.7	45.5	11.5	10.6
Chihuahua	Gómez Farías	64.1	8.6	17.5	62.1	10.1	9.3
Chihuahua	Gran Morelos	51.6	6.7	10.2	39.0	9.2	8.5

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Chihuahua	Guachochi	22.3	3.1	7.6	25.9	3.1	2.8
Chihuahua	Guadalupe	12.0	1.7	3.9	13.2	1.7	1.6
Chihuahua	Guadalupe y Calvo	45.2	5.9	8.7	33.6	8.1	7.5
Chihuahua	Guazapares	5.8	0.8	1.3	4.8	1.0	0.9
Chihuahua	Guerrero	186.1	25.7	61.8	213.9	26.1	24.0
Chihuahua	Hidalgo del Parral	41.6	5.7	12.8	44.7	6.1	5.6
Chihuahua	Hejotitán	73.8	9.9	17.7	64.9	12.3	11.3
Chihuahua	Ignacio Zaragoza	4.2	0.6	1.2	4.2	0.7	0.6
Chihuahua	Janos	44.0	6.0	13.6	47.6	6.5	5.9
Chihuahua	Jiménez	36.7	5.0	9.5	34.3	5.9	5.4
Chihuahua	Juárez	13.2	1.8	3.0	11.1	2.3	2.1
Chihuahua	Julimes	226.7	30.3	50.7	188.5	38.8	35.7
Chihuahua	López	120.8	16.7	38.7	134.6	17.4	16.0
Chihuahua	Madera	29.0	3.9	8.0	28.5	4.5	4.2
Chihuahua	Maguarichi	7.2	1.0	1.8	6.5	1.2	1.1
Chihuahua	Manuel Benavides	4.7	0.6	1.2	4.3	0.8	0.7
Chihuahua	Matachí	46.7	6.2	10.5	38.9	8.0	7.3
Chihuahua	Matamoros	3.3	0.5	1.0	3.5	0.5	0.5
Chihuahua	Meoqui	3.6	0.5	1.1	3.8	0.5	0.5
Chihuahua	Morelos	330.9	44.5	80.8	295.0	54.7	50.3
Chihuahua	Moris	309.6	43.0	105.6	363.8	42.6	39.2
Chihuahua	Namiquipa	14.6	2.0	4.4	15.6	2.2	2.0
Chihuahua	Nonoava	129.4	17.7	39.1	137.2	19.3	17.7
Chihuahua	Nuevo Casas Grandes	16.5	2.2	4.4	15.8	2.6	2.4
Chihuahua	Ocampo	48.8	6.7	14.6	51.2	7.3	6.7
Chihuahua	Ojinaga	34.1	4.6	9.0	32.5	5.4	5.0
Chihuahua	Praxedis G. Guerrero	100.7	13.7	28.9	102.3	15.4	14.2
Chihuahua	Riva Palacio	241.9	33.3	76.0	265.3	35.2	32.3
Chihuahua	Rosales	8.1	1.1	2.3	8.3	1.2	1.1
Chihuahua	Rosario	71.1	9.8	22.9	79.8	10.2	9.3
Chihuahua	San Francisco de Borja	100.3	13.8	31.3	109.4	14.6	13.5
Chihuahua	San Francisco de Conchos	3.1	0.4	1.1	3.7	0.4	0.4
Chihuahua	San Francisco del Oro	943.9	130.8	318.3	1,099.0	131.0	120.5
Chihuahua	Santa Bárbara	41.8	5.7	12.5	44.1	6.2	5.7
Chihuahua	Satevó	73.9	10.2	23.5	81.9	10.7	9.8
Chihuahua	Saucillo	366.3	49.1	85.6	315.5	61.6	56.7
Chihuahua	Temósachi	18.3	2.5	4.7	17.1	2.9	2.7
Chihuahua	El Tule	919.1	126.9	300.7	1,042.9	130.2	119.8
Chihuahua	Urique	103.1	13.7	22.5	84.0	17.8	16.4
Chihuahua	Uruachi	30.6	4.1	6.8	25.4	5.2	4.8
Chihuahua	Valle de Zaragoza	30.3	4.1	8.6	30.4	4.7	4.3
Total - State		***8,376.6***	***1,122.5***	***2,117.9***	***7,687.9***	***1,364.3***	***1,255.2***
Nuevo Leon	Abasolo	4.8	0.7	1.6	5.7	0.6	0.6
Nuevo Leon	Agualeguas	13.4	1.8	3.7	13.3	2.1	1.9
Nuevo Leon	Los Aldamas	53.9	7.5	18.3	63.3	7.4	6.8
Nuevo Leon	Allende	70.5	9.4	18.0	65.4	11.4	10.5
Nuevo Leon	Anáhuac	536.8	74.6	185.1	637.9	73.3	67.4
Nuevo Leon	Apodaca	48.3	6.5	13.1	46.9	7.6	7.0
Nuevo Leon	Aramberri	6.6	0.9	2.3	7.9	0.9	0.8
Nuevo Leon	Bustamante	301.6	40.1	75.5	275.4	49.2	45.3
Nuevo Leon	Cadereyta Jiménez	12.6	1.7	4.3	15.0	1.7	1.6
Nuevo Leon	Carmen	30.3	4.1	8.2	29.5	4.8	4.4
Nuevo Leon	Cerralvo	54.8	7.2	13.0	47.9	9.1	8.4
Nuevo Leon	Ciénega de Flores	21.2	2.9	7.3	25.2	2.9	2.7
Nuevo Leon	China	115.7	15.5	30.6	110.5	18.4	16.9
Nuevo Leon	Doctor Arroyo	4.3	0.6	1.5	5.1	0.6	0.5
Nuevo Leon	Doctor Coss	7.3	1.0	2.3	8.0	1.1	1.0
Nuevo Leon	Doctor González	292.5	38.2	61.9	234.3	50.9	46.8
Nuevo Leon	Galeana	58.7	8.1	19.5	67.7	8.2	7.5
Nuevo Leon	García	14.8	2.0	4.4	15.6	2.2	2.0
Nuevo Leon	San Pedro Garza García	447.1	62.1	153.3	528.7	61.3	56.4
Nuevo Leon	General Bravo	100.2	13.1	21.9	82.2	17.2	15.9
Nuevo Leon	General Escobedo	3.2	0.4	1.1	3.8	0.4	0.4
Nuevo Leon	General Terán	10.6	1.5	3.6	12.5	1.4	1.3
Nuevo Leon	General Treviño	15.2	2.1	4.6	16.1	2.3	2.1
Nuevo Leon	General Zaragoza	1,270.2	176.5	437.7	1,508.9	173.4	159.5
Nuevo Leon	General Zuazua	27.0	3.8	9.3	32.1	3.7	3.4
Nuevo Leon	Guadalupe	2.6	0.4	0.9	3.1	0.4	0.3
Nuevo Leon	Los Herreras	18.5	2.5	5.2	18.7	2.8	2.6
Nuevo Leon	Higueras	6.6	0.9	2.3	7.8	0.9	0.8
Nuevo Leon	Hualahuises	131.0	18.1	44.3	153.0	18.1	16.7

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Nuevo Leon	Iurbide	17.6	2.4	4.7	17.0	2.8	2.6
Nuevo Leon	Juárez	243.7	32.6	63.9	231.0	38.9	35.8
Nuevo Leon	Lampazos de Naranjo	36.3	4.7	6.9	26.7	6.5	6.0
Nuevo Leon	Linares	5.3	0.7	1.8	6.3	0.7	0.7
Nuevo Leon	Marín	25.7	3.4	6.4	23.3	4.2	3.9
Nuevo Leon	Melchor Ocampo	8.9	1.2	3.1	10.6	1.2	1.1
Nuevo Leon	Mier y Noriega	2.3	0.3	0.8	2.7	0.3	0.3
Nuevo Leon	Mina	15.9	2.2	5.0	17.6	2.3	2.1
Nuevo Leon	Montemorelos	17.2	2.3	4.6	16.4	2.7	2.5
Nuevo Leon	Monterrey	118.8	16.3	37.6	131.4	17.2	15.8
Nuevo Leon	Parás	2,103.6	292.3	725.3	2,500.1	287.1	264.1
Nuevo Leon	Pesquería	2.3	0.3	0.8	2.8	0.3	0.3
Nuevo Leon	Los Ramones	59.4	7.8	13.7	50.8	10.0	9.2
Nuevo Leon	Rayones	4.9	0.7	1.7	5.9	0.7	0.6
Nuevo Leon	Sabinas Hidalgo	86.5	11.7	25.3	89.7	13.1	12.0
Nuevo Leon	Salinas Victoria	49.9	6.8	14.7	52.1	7.5	6.9
Nuevo Leon	San Nicolás de los Garza	940.8	130.7	324.4	1,118.1	128.4	118.1
Nuevo Leon	Hidalgo	238.5	33.1	82.2	283.5	32.6	29.9
Nuevo Leon	Santa Catarina	429.9	59.7	148.2	510.9	58.7	54.0
Nuevo Leon	Santiago	69.7	9.7	24.0	82.8	9.5	8.8
Nuevo Leon	Vallecillo	29.4	3.8	5.6	21.8	5.3	4.9
Nuevo Leon	Villaldama	15.6	2.1	4.0	14.6	2.5	2.3
Total - State		***8,202.6***	***1,129.1***	***2,659.6***	***9,257.6***	***1,167.0***	***1,073.6***
Sonora	Aconchi	5.8	0.8	1.8	6.3	0.9	0.8
Sonora	Agua Prieta	152.1	20.7	46.9	162.9	22.4	20.6
Sonora	Alamos	71.9	9.7	20.7	73.0	11.0	10.1
Sonora	Altar	36.3	4.8	8.6	31.5	6.1	5.6
Sonora	Arivechi	5.2	0.7	1.4	4.9	0.8	0.8
Sonora	Arizpe	19.5	2.5	4.4	16.4	3.3	3.0
Sonora	Atil	2.6	0.3	0.7	2.4	0.4	0.4
Sonora	Bacadéhuachi	3.8	0.5	1.1	3.9	0.6	0.5
Sonora	Bacanora	1.8	0.3	0.6	2.1	0.2	0.2
Sonora	Bacerac	2.6	0.4	0.9	3.1	0.4	0.3
Sonora	Bacoachi	5.2	0.7	1.4	5.0	0.8	0.8
Sonora	Bácum	195.0	25.2	40.0	151.7	34.4	31.6
Sonora	Banámichi	11.1	1.4	2.4	8.9	1.9	1.8
Sonora	Baviácora	11.9	1.6	3.3	11.6	1.9	1.7
Sonora	Bavispe	17.9	2.3	3.5	13.4	3.2	3.0
Sonora	Benjamín Hill	42.0	5.8	14.6	49.6	5.7	5.3
Sonora	Caborca	13.4	1.8	4.2	14.6	1.9	1.8
Sonora	Cajeme	333.6	43.9	79.9	292.0	55.6	51.1
Sonora	Cananea	1,268.4	169.1	335.7	1,200.9	202.5	186.3
Sonora	Carbó	82.8	11.2	25.0	87.1	12.4	11.4
Sonora	La Colorada	10.8	1.5	3.5	12.1	1.5	1.4
Sonora	Cucurpe	17.1	2.2	3.2	12.4	3.1	2.9
Sonora	Cumpas	28.4	3.7	6.9	25.1	4.7	4.3
Sonora	Divisaderos	11.0	1.4	2.1	8.2	2.0	1.8
Sonora	Empalme	145.5	19.6	41.7	146.8	22.3	20.6
Sonora	Etchojoa	381.9	49.7	83.3	311.1	65.9	60.6
Sonora	Fronteras	52.6	6.9	11.5	42.9	9.1	8.4
Sonora	Granados	42.9	5.7	11.1	39.8	6.9	6.4
Sonora	Guaymas	5.9	0.8	1.4	5.2	1.0	0.9
Sonora	Hermosillo	656.3	86.2	155.0	568.1	110.0	101.2
Sonora	Huachinera	1,274.0	175.7	424.6	1,454.6	178.9	164.6
Sonora	Huásabas	3.4	0.5	1.0	3.4	0.5	0.5
Sonora	Huatabampo	4.2	0.6	1.0	3.8	0.7	0.6
Sonora	Huépac	276.1	36.8	72.6	260.1	44.2	40.7
Sonora	Imuris	2.2	0.3	0.8	2.6	0.3	0.3
Sonora	Magdalena	28.6	3.9	8.3	29.0	4.4	4.0
Sonora	Mazatán	9.1	1.2	2.3	8.4	1.5	1.4
Sonora	Moctezuma	56.4	7.7	17.9	61.9	8.2	7.5
Sonora	Naco	12.5	1.6	2.6	9.9	2.2	2.0
Sonora	Nácori Chico	16.3	2.2	4.2	15.0	2.6	2.4
Sonora	Nacozari de García	18.6	2.5	5.0	17.7	2.9	2.7
Sonora	Navojoa	6.7	0.9	1.9	6.7	1.0	0.9
Sonora	Nogales	27.6	3.8	9.6	32.7	3.8	3.5
Sonora	Onavas	366.9	49.8	110.2	384.4	54.9	50.5
Sonora	Opodepe	322.6	44.6	109.4	373.6	44.8	41.2
Sonora	Oquitoa	3.3	0.4	0.7	2.7	0.6	0.5
Sonora	Pitiquito	11.3	1.5	2.9	10.4	1.8	1.7
Sonora	Puerto Peñasco	18.4	2.3	3.2	12.7	3.4	3.1

Nonroad Sources
1999 Emissions Inventory for the Six Northern Mexican States (Final)
Mg/Year, by Municipality

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Sonora	Quiriego	53.0	6.9	12.1	44.6	9.0	8.3
Sonora	Rayón	64.6	8.9	21.6	74.0	9.1	8.3
Sonora	Rosario	33.5	4.3	6.8	25.7	5.9	5.5
Sonora	Sahuaripa	5.4	0.7	1.5	5.2	0.9	0.8
Sonora	San Felipe de Jesús	16.3	2.2	4.6	16.3	2.5	2.3
Sonora	San Javier	18.2	2.5	5.3	18.5	2.8	2.6
Sonora	San Luis Río Colorado	2.0	0.3	0.5	1.7	0.3	0.3
Sonora	San Miguel de Horcasitas	26.3	3.7	9.2	31.1	3.6	3.3
Sonora	San Pedro de la Cueva	0.5	0.1	0.2	0.6	0.1	0.1
Sonora	Santa Ana	723.3	95.1	171.3	627.5	121.1	111.4
Sonora	Santa Cruz	48.4	6.3	10.1	38.0	8.5	7.8
Sonora	Sáric	6.8	0.9	1.7	6.2	1.1	1.0
Sonora	Soyopa	46.0	6.1	12.4	44.1	7.3	6.7
Sonora	Suaqui Grande	59.6	7.6	10.5	41.5	11.0	10.1
Sonora	Tepache	22.0	2.8	4.5	16.9	3.9	3.6
Sonora	Trincheras	9.1	1.2	2.1	7.7	1.5	1.4
Sonora	Tubutama	19.9	2.5	3.7	14.5	3.6	3.3
Sonora	Ures	3.0	0.4	1.0	3.5	0.4	0.4
Sonora	Villa Hidalgo	4.6	0.6	1.4	4.8	0.7	0.6
Sonora	Villa Pesqueira	23.4	3.0	4.5	17.5	4.2	3.9
Sonora	Yécora	33.7	4.5	9.0	32.0	5.4	4.9
Sonora	General Plutarco Elías Calles	7.3	1.0	1.9	6.9	1.2	1.1
Sonora	Benito Juárez	13.6	1.8	2.8	10.7	2.4	2.2
Sonora	San Ignacio Río Muerto	15.2	2.1	4.6	16.2	2.3	2.1
Total - State		***7,349.1***	***983.3***	***1,998.2***	***7,108.2***	***1,158.3***	***1,065.6***
Tamaulipas	Abasolo	288.9	36.3	53.2	208.8	52.5	48.3
Tamaulipas	Aldama	370.5	46.9	72.3	279.4	66.2	60.9
Tamaulipas	Altamira	556.5	73.1	139.9	511.0	90.6	83.3
Tamaulipas	Antiguo Morelos	66.0	8.5	14.3	53.9	11.4	10.5
Tamaulipas	Burgos	127.7	16.0	23.3	91.6	23.3	21.4
Tamaulipas	Bustamante	21.0	2.8	6.3	22.2	3.1	2.9
Tamaulipas	Camargo	131.6	16.9	28.2	106.6	22.8	21.0
Tamaulipas	Casas	89.8	11.3	16.7	65.3	16.3	15.0
Tamaulipas	Ciudad Madero	377.1	52.4	129.9	448.4	51.5	47.3
Tamaulipas	Cruillas	21.3	2.7	4.4	16.8	3.7	3.4
Tamaulipas	Gómez Farías	929.3	119.0	196.8	746.1	161.6	148.7
Tamaulipas	González	63.4	8.1	13.8	51.9	10.9	10.1
Tamaulipas	Güémez	641.4	81.0	122.5	476.3	115.3	106.1
Tamaulipas	Guerrero	181.7	23.0	35.7	137.9	32.4	29.8
Tamaulipas	Gustavo Díaz Ordaz	21.8	2.8	5.3	19.4	3.6	3.3
Tamaulipas	Hidalgo	156.1	19.9	32.1	122.5	27.4	25.2
Tamaulipas	Jaumave	287.9	36.5	57.1	219.8	51.2	47.1
Tamaulipas	Jiménez	49.2	6.5	13.1	47.2	7.8	7.2
Tamaulipas	Llera	39.5	5.2	9.7	35.7	6.5	6.0
Tamaulipas	Mainero	254.0	32.1	49.0	189.9	45.5	41.9
Tamaulipas	El Mante	40.6	5.1	7.8	30.4	7.3	6.7
Tamaulipas	Matamoros	2,389.3	309.8	552.9	2,055.4	402.2	370.1
Tamaulipas	Méndez	159.1	20.0	28.6	112.9	29.1	26.8
Tamaulipas	Mier	14.0	2.0	4.8	16.7	1.9	1.8
Tamaulipas	Miguel Alemán	53.2	7.4	18.3	63.2	7.3	6.7
Tamaulipas	Miquihuana	13.9	1.8	3.5	12.7	2.3	2.1
Tamaulipas	Nuevo Laredo	789.2	107.5	245.9	863.2	115.0	105.8
Tamaulipas	Nuevo Morelos	22.8	2.9	4.9	18.6	3.9	3.6
Tamaulipas	Ocampo	93.3	12.0	20.5	77.0	16.0	14.7
Tamaulipas	Padilla	229.4	28.9	43.4	169.1	41.3	38.0
Tamaulipas	Palmillas	5.6	0.8	1.6	5.7	0.9	0.8
Tamaulipas	Reynosa	1,363.1	182.2	382.1	1,366.6	210.7	193.8
Tamaulipas	Río Bravo	954.1	121.8	197.8	753.8	167.1	153.7
Tamaulipas	San Carlos	74.6	9.6	16.0	60.5	12.9	11.9
Tamaulipas	San Fernando	1,317.9	165.7	241.6	949.0	239.8	220.6
Tamaulipas	San Nicolás	2.2	0.3	0.8	2.6	0.3	0.3
Tamaulipas	Soto la Marina	300.5	38.1	59.2	228.3	53.5	49.2
Tamaulipas	Tampico	612.8	85.1	210.7	727.9	83.7	77.0
Tamaulipas	Tula	85.2	11.4	24.2	86.2	13.1	12.0
Tamaulipas	Valle Hermoso	625.7	79.6	126.1	483.9	110.6	101.7
Tamaulipas	Victoria	637.3	87.2	203.0	709.8	91.6	84.3
Tamaulipas	Villagrán	74.8	9.5	15.1	57.9	13.2	12.2
Tamaulipas	Xicoténcatl	150.7	19.4	33.4	125.4	25.8	23.7
Total - State		***14,683.8***	***1,909.5***	***3,465.4***	***12,827.5***	***2,453.1***	***2,256.9***
Total - Six States		***51,320.1***	***6,851.2***	***13,673.1***	***49,065.5***	***8,156.8***	***7,504.3***

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Baja California	Ensenada	1,267.0		5,401.5			
Baja California	Mexicali	2,021.8		10,367.5			
Baja California	Tecate	1,009.1		2,600.1			
Baja California	Tijuana	118.4		213.3			
Baja California	Playas de Rosarito	36.5		62.1			
Total - State		***4,452.8***	***0.0***	***18,644.6***	***0.0***	***0.0***	***0.0***
Coahuila	Abasolo	298.1		2,791.0			
Coahuila	Acuña	4,252.5		24,563.1			
Coahuila	Allende	232.0		497.4			
Coahuila	Arteaga	873.9		5,522.6			
Coahuila	Candela	805.5		5,024.2			
Coahuila	Castaños	1,219.4		5,741.1			
Coahuila	Cuatrociénegas	3,998.7		25,902.4			
Coahuila	Escobedo	405.5		1,521.4			
Coahuila	Francisco I. Madero	2,297.0		5,836.3			
Coahuila	Frontera	333.4		1,040.7			
Coahuila	General Cepeda	678.0		2,848.3			
Coahuila	Guerrero	1,430.2		4,152.1			
Coahuila	Hidalgo	880.5		3,044.0			
Coahuila	Jiménez	1,772.1		3,728.6			
Coahuila	Juárez	421.9		1,430.1			
Coahuila	Lamadrid	322.8		1,780.7			
Coahuila	Matamoros	835.1		1,009.6			
Coahuila	Monclova	928.2		2,136.2			
Coahuila	Morelos	194.1		393.0			
Coahuila	Múzquiz	3,680.3		46,038.7			
Coahuila	Nadadores	293.1		905.9			
Coahuila	Nava	698.9		2,715.7			
Coahuila	Ocampo	6,988.3		84,016.2			
Coahuila	Parras	3,151.1		30,363.5			
Coahuila	Piedras Negras	466.8		1,284.1			
Coahuila	Progreso	880.1		2,458.1			
Coahuila	Ramos Arizpe	1,724.3		4,860.2			
Coahuila	Sabinas	1,092.8		3,592.0			
Coahuila	Sacramento	67.7		2,833.0			
Coahuila	Saltillo	2,044.3		12,286.0			
Coahuila	San Buenaventura	2,768.5		10,946.1			
Coahuila	San Juan de Sabinas	354.8		1,145.8			
Coahuila	San Pedro	5,778.8		20,446.1			
Coahuila	Sierra Mojada	1,107.5		15,309.2			
Coahuila	Torreón	537.1		970.0			
Coahuila	Viesca	3,088.7		4,470.3			
Coahuila	Villa Unión	1,547.1		2,879.0			
Coahuila	Zaragoza	3,632.0		29,590.8			
Total - State		***62,081.1***	***0.0***	***376,073.7***	***0.0***	***0.0***	***0.0***
Chihuahua	Ahumada	1,331.2		41,097.5			
Chihuahua	Aldama	1,461.5		13,400.4			
Chihuahua	Allende	369.3		1,910.3			
Chihuahua	Aquiles Serdán	281.3		630.3			
Chihuahua	Ascensión	1,208.2		44,850.1			
Chihuahua	Bachíniva	685.7		8,133.2			
Chihuahua	Balleza	570.5		103,864.4			
Chihuahua	Batopilas	229.8		43,305.6			
Chihuahua	Bocoyna	387.9		40,315.2			
Chihuahua	Buenaventura	1,184.7		36,716.8			
Chihuahua	Camargo	1,159.1		19,305.6			
Chihuahua	Carichí	728.2		54,143.5			
Chihuahua	Casas Grandes	563.6		72,947.6			
Chihuahua	Coronado	437.2		3,398.7			
Chihuahua	Coyame del Sotol	1,232.2		14,291.6			
Chihuahua	La Cruz	346.6		2,625.4			
Chihuahua	Cuauhtémoc	3,380.2		49,689.4			
Chihuahua	Cusihuiriachi	1,366.1		13,221.2			
Chihuahua	Chihuahua	2,080.6		92,759.1			
Chihuahua	Chínipas	125.5		23,920.6			
Chihuahua	Delicias	170.9		564.8			
Chihuahua	Dr. Belisario Domínguez	309.3		7,043.3			
Chihuahua	Galeana	373.8		11,952.3			
Chihuahua	Santa Isabel	659.4		4,740.7			
Chihuahua	Gómez Farías	444.3		10,486.2			
Chihuahua	Gran Morelos	316.3		7,256.6			

Natural Sources
1999 Emissions Inventory for the Six Northern States (Final)
Mg/Year, by Municipality

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Chihuahua	Guachochi	1,055.7		133,840.5			
Chihuahua	Guadalupe	1,294.4		4,530.3			
Chihuahua	Guadalupe y Calvo	740.0		162,283.5			
Chihuahua	Guazapares	121.9		37,603.6			
Chihuahua	Guerrero	1,901.9		54,744.4			
Chihuahua	Hidalgo del Parral	465.4		5,409.3			
Chihuahua	Hejotitán	669.4		962.1			
Chihuahua	Ignacio Zaragoza	1,153.5		60,766.3			
Chihuahua	Janos	1,264.8		49,709.5			
Chihuahua	Jiménez	2,728.7		13,290.0			
Chihuahua	Juárez	421.6		3,742.6			
Chihuahua	Julimes	1,148.2		2,497.4			
Chihuahua	López	303.6		1,020.6			
Chihuahua	Madera	913.2		112,998.1			
Chihuahua	Maguarichi	58.7		15,615.6			
Chihuahua	Manuel Benavides	593.8		5,054.4			
Chihuahua	Matachí	313.9		7,416.2			
Chihuahua	Matamoros	544.3		15,922.3			
Chihuahua	Meoqui	126.3		267.7			
Chihuahua	Morelos	306.0		75,780.1			
Chihuahua	Moris	106.1		34,098.5			
Chihuahua	Namiquipa	2,869.4		49,050.4			
Chihuahua	Nonoava	450.5		47,244.7			
Chihuahua	Nuevo Casas Grandes	768.1		6,422.7			
Chihuahua	Ocampo	111.6		24,102.5			
Chihuahua	Ojinaga	1,493.5		7,182.8			
Chihuahua	Praxedis G. Guerrero	300.4		340.5			
Chihuahua	Riva Palacio	2,217.0		25,915.1			
Chihuahua	Rosales	427.0		2,672.3			
Chihuahua	Rosario	354.6		15,484.9			
Chihuahua	San Francisco de Borja	513.0		43,090.0			
Chihuahua	San Francisco de Conchos	175.2		1,078.3			
Chihuahua	San Francisco del Oro	94.7		2,847.3			
Chihuahua	Santa Bárbara	94.6		7,325.6			
Chihuahua	Satevó	1,263.6		12,947.4			
Chihuahua	Saucillo	1,213.1		5,029.3			
Chihuahua	Temósachi	846.6		81,236.6			
Chihuahua	El Tule	60.0		8,585.9			
Chihuahua	Urique	166.6		34,115.4			
Chihuahua	Uruachi	70.0		29,396.4			
Chihuahua	Valle de Zaragoza	581.2		2,402.2			
Total - State		***51,705.5***	***0.0***	***1,926,593.9***	***0.0***	***0.0***	***0.0***
Nuevo Leon	Abasolo	14.2		30.5			
Nuevo Leon	Agualeguas	418.8		1,155.3			
Nuevo Leon	Los Aldamas	297.5		777.1			
Nuevo Leon	Allende	52.4		4,226.1			
Nuevo Leon	Anáhuac	2,494.4		8,326.4			
Nuevo Leon	Apodaca	162.2		487.3			
Nuevo Leon	Aramberri	1,370.8		36,753.3			
Nuevo Leon	Bustamante	210.2		756.0			
Nuevo Leon	Cadereyta Jiménez	1,274.2		3,217.1			
Nuevo Leon	Carmen	54.2		121.7			
Nuevo Leon	Cerralvo	417.0		1,625.4			
Nuevo Leon	Ciénega de Flores	56.0		208.8			
Nuevo Leon	China	1,991.9		8,995.1			
Nuevo Leon	Doctor Arroyo	4,863.4		9,925.6			
Nuevo Leon	Doctor Coss	725.2		835.9			
Nuevo Leon	Doctor González	276.0		1,765.2			
Nuevo Leon	Galeana	2,985.6		22,309.4			
Nuevo Leon	García	475.5		1,610.8			
Nuevo Leon	San Pedro Garza García	27.6		96.0			
Nuevo Leon	General Bravo	1,578.9		2,732.2			
Nuevo Leon	General Escobedo	91.0		843.3			
Nuevo Leon	General Terán	2,734.6		3,057.6			
Nuevo Leon	General Treviño	124.9		460.5			
Nuevo Leon	General Zaragoza	565.4		29,840.7			
Nuevo Leon	General Zuazua	74.5		250.4			
Nuevo Leon	Guadalupe	45.8		467.3			
Nuevo Leon	Los Herreras	387.1		746.0			
Nuevo Leon	Higueras	266.1		3,412.4			
Nuevo Leon	Hualahuises	250.1		524.9			

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Nuevo Leon	Iurbide	410.5		15,335.5			
Nuevo Leon	Juárez	122.0		1,131.5			
Nuevo Leon	Lampazos de Naranjo	1,530.9		3,962.0			
Nuevo Leon	Linares	2,091.0		24,210.6			
Nuevo Leon	Marín	68.2		447.9			
Nuevo Leon	Melchor Ocampo	90.0		209.2			
Nuevo Leon	Mier y Noriega	611.8		1,466.8			
Nuevo Leon	Mina	1,106.8		6,098.9			
Nuevo Leon	Montemorelos	2,055.5		19,928.6			
Nuevo Leon	Monterrey	137.3		1,342.5			
Nuevo Leon	Parás	523.0		1,666.2			
Nuevo Leon	Pesquería	294.3		407.5			
Nuevo Leon	Los Ramones	979.2		1,736.8			
Nuevo Leon	Rayones	472.3		11,613.9			
Nuevo Leon	Sabinas Hidalgo	861.5		2,686.8			
Nuevo Leon	Salinas Victoria	766.5		3,840.4			
Nuevo Leon	San Nicolás de los Garza	47.4		84.8			
Nuevo Leon	Hidalgo	48.3		207.3			
Nuevo Leon	Santa Catarina	418.6		6,018.2			
Nuevo Leon	Santiago	312.1		12,311.9			
Nuevo Leon	Vallecillo	1,144.0		2,411.3			
Nuevo Leon	Villaldama	639.6		2,817.3			
Total - State		***39,016.4***	***0.0***	***265,494.1***	***0.0***	***0.0***	***0.0***
Sonora	Aconchi	75.3		2,070.5			
Sonora	Agua Prieta	392.3		21,476.5			
Sonora	Alamos	1,850.1		113,651.4			
Sonora	Altar	1,169.5		3,465.0			
Sonora	Arivechi	62.0		6,426.9			
Sonora	Arizpe	269.4		24,307.2			
Sonora	Atil	37.1		15.7			
Sonora	Bacadéhuachi	359.2		2,207.6			
Sonora	Bacanora	63.1		11,143.5			
Sonora	Bacerac	92.9		16,236.7			
Sonora	Bacoachi	77.8		9,780.4			
Sonora	Bácum	704.1		1,467.9			
Sonora	Banámichi	263.0		5,026.1			
Sonora	Baviácora	279.5		3,636.7			
Sonora	Bavispe	92.9		21,792.4			
Sonora	Benjamín Hill	174.5		796.5			
Sonora	Caborca	3,272.6		9,522.4			
Sonora	Cajeme	3,853.5		25,489.0			
Sonora	Cananea	146.9		16,636.6			
Sonora	Carbó	770.5		2,299.1			
Sonora	La Colorada	2,101.3		10,447.5			
Sonora	Cucurpe	112.2		6,794.4			
Sonora	Cumpas	434.4		9,877.1			
Sonora	Divisaderos	343.7		679.9			
Sonora	Empalme	547.8		1,381.1			
Sonora	Etchojoa	2,220.6		960.1			
Sonora	Fronteras	223.4		26,660.6			
Sonora	Granados	72.8		514.1			
Sonora	Guaymas	5,362.7		17,432.8			
Sonora	Hermosillo	9,560.4		27,106.7			
Sonora	Huachinera	350.6		19,309.8			
Sonora	Huásabas	101.4		6,163.1			
Sonora	Huatabampo	1,349.6		3,256.6			
Sonora	Huépac	179.3		2,387.9			
Sonora	Imuris	90.5		9,788.9			
Sonora	Magdalena	138.9		266.7			
Sonora	Mazatán	494.4		2,268.9			
Sonora	Moctezuma	788.1		5,002.0			
Sonora	Naco	155.5		3,173.9			
Sonora	Nácori Chico	734.7		21,575.9			
Sonora	Nacozari de García	51.2		15,265.6			
Sonora	Navojoa	2,620.7		5,036.6			
Sonora	Nogales	121.1		4,878.1			
Sonora	Onavas	74.1		6,340.1			
Sonora	Opodepe	481.7		1,901.8			
Sonora	Oquitoa	84.6		167.4			
Sonora	Pitiquito	2,063.8		5,884.2			
Sonora	Puerto Peñasco	255.2		5,879.8			

State	Municipality	NO_x	SO_x	VOC	CO	PM_{10}	$PM_{2.5}$
Sonora	Quiriego	1,097.3		47,451.1			
Sonora	Rayón	468.6		924.0			
Sonora	Rosario	446.7		30,267.0			
Sonora	Sahuaripa	646.0		41,795.1			
Sonora	San Felipe de Jesús	48.0		1,602.7			
Sonora	San Javier	106.6		12,215.2			
Sonora	San Luis Río Colorado	807.8		7,523.8			
Sonora	San Miguel de Horcasitas	485.6		938.0			
Sonora	San Pedro de la Cueva	723.4		19,459.1			
Sonora	Santa Ana	255.7		796.5			
Sonora	Santa Cruz	66.6		3,686.9			
Sonora	Sáric	56.1		208.7			
Sonora	Soyopa	173.2		34,673.0			
Sonora	Suaqui Grande	373.5		6,215.2			
Sonora	Tepache	491.8		1,475.1			
Sonora	Trincheras	741.7		1,160.0			
Sonora	Tubutama	95.0		751.0			
Sonora	Ures	1,677.6		4,096.7			
Sonora	Villa Hidalgo	66.3		7,445.3			
Sonora	Villa Pesqueira	639.6		7,276.5			
Sonora	Yécora	159.3		29,407.3			
Sonora	General Plutarco Elías Calles	964.7		1,439.7			
Sonora	Benito Juárez	466.3		791.8			
Sonora	San Ignacio Río Muerto	423.9		8,638.8			
Total - State		***56,601.9***	***0.0***	***788,088.4***	***0.0***	***0.0***	***0.0***
Tamaulipas	Abasolo	4,281.5		3,326.6			
Tamaulipas	Aldama	308.3		4,968.7			
Tamaulipas	Altamira	117.1		929.4			
Tamaulipas	Antiguo Morelos	184.6		12,469.0			
Tamaulipas	Burgos	4,597.8		2,130.2			
Tamaulipas	Bustamante	1,048.5		1,673.3			
Tamaulipas	Camargo	348.8		1,111.1			
Tamaulipas	Casas	814.8		32,105.4			
Tamaulipas	Ciudad Madero	0.0		0.0			
Tamaulipas	Cruillas	1,202.1		1,973.7			
Tamaulipas	Gómez Farías	1,117.2		11,679.7			
Tamaulipas	González	3,877.4		8,906.9			
Tamaulipas	Güémez	2,827.2		15,460.8			
Tamaulipas	Guerrero	1,155.2		8,550.5			
Tamaulipas	Gustavo Díaz Ordaz	131.2		480.6			
Tamaulipas	Hidalgo	1,418.5		89,723.7			
Tamaulipas	Jaumave	579.5		72,613.7			
Tamaulipas	Jiménez	2,795.0		4,563.9			
Tamaulipas	Llera	1,627.6		29,748.4			
Tamaulipas	Mainero	394.8		3,749.8			
Tamaulipas	El Mante	2,389.2		8,081.9			
Tamaulipas	Matamoros	1,230.4		553.7			
Tamaulipas	Méndez	5,211.5		1,406.4			
Tamaulipas	Mier	377.4		915.2			
Tamaulipas	Miguel Alemán	512.2		566.2			
Tamaulipas	Miquihuana	525.6		8,625.5			
Tamaulipas	Nuevo Laredo	647.1		4,567.2			
Tamaulipas	Nuevo Morelos	173.1		7,525.1			
Tamaulipas	Ocampo	586.3		40,407.6			
Tamaulipas	Padilla	850.9		1,146.3			
Tamaulipas	Palmillas	136.9		11,715.2			
Tamaulipas	Reynosa	6,755.9		2,621.2			
Tamaulipas	Río Bravo	8,048.3		487.8			
Tamaulipas	San Carlos	2,237.1		4,537.2			
Tamaulipas	San Fernando	7,236.8		1,185.7			
Tamaulipas	San Nicolás	350.3		981.4			
Tamaulipas	Soto la Marina	443.9		12,409.9			
Tamaulipas	Tampico	0.6		14.4			
Tamaulipas	Tula	591.1		35,409.4			
Tamaulipas	Valle Hermoso	3,439.8		209.0			
Tamaulipas	Victoria	1,927.6		9,898.6			
Tamaulipas	Villagrán	2,352.6		4,349.1			
Tamaulipas	Xicoténcatl	4,548.4		2,564.9			
Total - State		***79,399.9***	***0.0***	***466,344.3***	***0.0***	***0.0***	***0.0***
Total - Six States		***293,257.6***	***0.0***	***3,841,239.0***	***0.0***	***0.0***	***0.0***