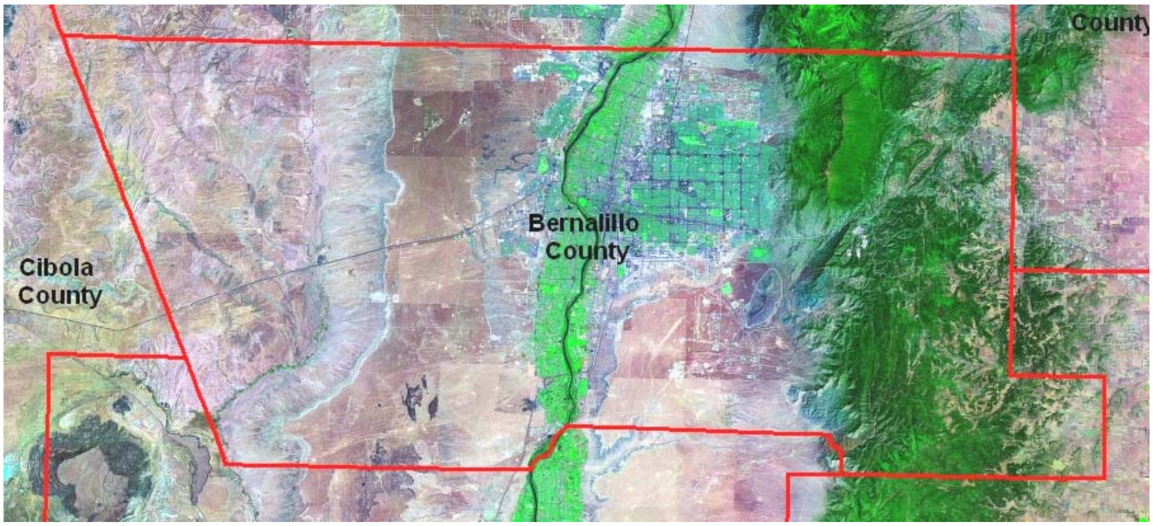
FINAL

Bernalillo County PM_{10} Emission Inventory for 2004



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ACRONYMS

°C	degrees Celsius
µg	microgram (10^{-6} g)
µm	micron or micrometer (10^{-6} m)
ABL	Atmospheric Boundary Layer
ADTV	Average Daily Traffic Volume
AGL	Above Ground Level
ASTM	American Society for Testing and Materials
ATP	Anti-Tampering Program
BACM	Best Available Control Measures
BLM	Bureau of Land Management
CARB	California Air Resources Board
CEFA	Program for Climate, Ecosystem and Fire Applications
CFCC	Census Feature Class Code
CFR	Code of Federal Regulations
CMU	Carnegie Mellon University
CNG	Compressed Natural Gas
COA	City of Albuquerque
DLG	Digital Line Graph
DVMT	Daily Vehicle Miles Traveled
DOQ	Digital Orthophoto Quadrangle
DRG	Digital Raster Graphic
DRI	Desert Research Institute
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Institute
FGDC	Federal Geographic Data Committee
GIS	Geographic Information System
GPS	Global Positioning System
GRS80	Geodetic Reference System of 1980
HARN	High Accuracy Reference Network datum
HBX	High Binary Explosive
HDDV	Heavy Duty Diesel Vehicles
ISO	International Organization for Standardization
km	kilometer (10^3 m)
LPG	Liquid Petroleum Gas
m	meter
m^3	cubic meter
mb	millibar
mm	millimeter
m/s	meter per second
MMT	Manure Management Train
MRCOG	Mid-Region Council of Governments
MRI	Midwest Research Institute
MSL	Mean Sea Level

MSA	Metropolitan Statistical Area
MW	MegaWatt
NAAQS	National Ambient Air Quality Standards
NAD27	North American Datum of 1927
NAD83	North American Datum of 1983
NCDC	National Climatic Data Center
NEI	National Emission Inventory
NH_3	ammonia
NH_4^+	ammonium ion
NH_4NO_3	ammonium nitrate
$(NH_4)_2SO_4$	ammonium sulfate
NLCD	National Land Cover Database
NMDA	New Mexico Department of Agriculture
NMIM	National Mobile Inventory Model
NO_2	nitrogen dioxide
NO_3^-	nitrate ion
NO_X	nitrogen oxides
NPS	National Park Service
NSR	New Source Review
NWS	National Weather Service
O_3	ozone
OBODM	Open Burn/Open Detonation Dispersion Model
OSD	Ozone Season Day
PBL	Planetary Boundary Layer
PI-SWERL	Portable In-Situ Wind ERosion Laboratory
PM	suspended Particulate Matter with no regard to size of particles
PM_{10}	suspended Particulate Matter with aerodynamic diameters less than 10 microns (µm)
$PM_{2.5}$	suspended Particulate Matter with aerodynamic diameters less than 2.5 microns (µm)
POTW	Publicly-Owned Treatment Works
ppb *or* ppbv	parts per billion volume
ppm *or* ppmv	parts per million volume
PSD	Prevention of Significant Deterioration
RDX	Research Department eXplosive
RVP	Reid Vapor Pressure
SAF	Seasonal Adjustment Factors
SCAQMD	South Coast Air Quality Management District
SCC	Source Classification Code
SIP	State Implementation Plan
SLAMS	State/Local Air Monitoring Stations
SSURGO	Soil Survey Geographic database
STATSGO	State Soil Geographic database
TIGER®	Topologically Integrated Geographic Encoding and Referencing
TM	Thematic Mapper (Landsat)
TPY	Tons Per Year

TRAKER	Testing Re-entrained Aerosol Kinetic Emissions from Roads
TRS	Township, Range and Section
U.S. EPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Service
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
WEG	Wind Erosion Group
WEQ	Wind Erosion eQuation
WGS84	World Geodetic System of 1984
WRCC	Western Regional Climate Center
XML	Extensible Markup Language

1. INTRODUCTION

PM_{10} refers to particulate matter (PM) of 10 microns or less in aerodynamic diameter. Another class of particles, denoted as $PM_{2.5}$ (also called as fine particles), refers to particles of 2.5 microns or less in aerodynamic diameter. While fine particles originate mostly from combustion sources and secondary aerosol generation processes, coarse particles (PM_{10} minus $PM_{2.5}$) originate from mechanical activities and fugitive source categories. Major sources of PM_{10} typically include fugitive dust, open burning including wild fires, crushing and grinding operations, agricultural activities such as land tilling, dust on paved and unpaved roads and to a lesser extent from fuel combustion sources and mobile source exhaust.

The objective of this work was to develop a PM_{10} emission inventory for sources within Bernalillo County, New Mexico. The inventory contains emission data from point, area and mobile sources.

1.1 Inventory Year

The emission inventory base year is 2004. All emissions activity data except for burning were specific to the year 2004. For open burning, 2005 data was used since the 2004 database was not complete and would not provide enough detail for an inventory.

1.2 Geographic Domain

A map of Bernalillo County, NM showing the urban area of the city of Albuquerque and the traffic network is illustrated in Figure 2-1. During 2004 Bernalillo County has an estimated population of 593,765 residents. This represents a growth rate from 2000 of 6.7% (Census Bureau, 2005). According to the US Census Bureau, the Bernalillo County covers a total area of 3031.6 km^2, thus a population density of almost 195.8 people per square kilometer. Within the county, the urbanized area with population of 500,000 inhabitants, has a population density more than 1,000 inhabitants per square kilometer. The County shares its borders with Sandoval County to the north; Santa Fe and Torrance Counties to the east; Valencia County to the south; and Cibola County to the west. Bernalillo County also covers portions of the Isleta Pueble to the south, Laguna Pueblo to the west, Navajo to the west and Sandia Pueblo to the north.

1.3 Pollutant

The emissions inventoried in this report are for PM_{10}. This inventory only includes direct emissions and does not include emissions that occur as part of chemical reactions in the atmosphere. Gaseous ammonia (NH_3) emissions were calculated for livestock, fertilizer use, humans, wildlife, pets publically-owned treatment works and soil.

1.4 Spatial Resolution

Emissions are reported as totals for Bernalillo County. Data used in the calculation of county totals vary in resolution from county averaged to GIS data with accuracy in meters.

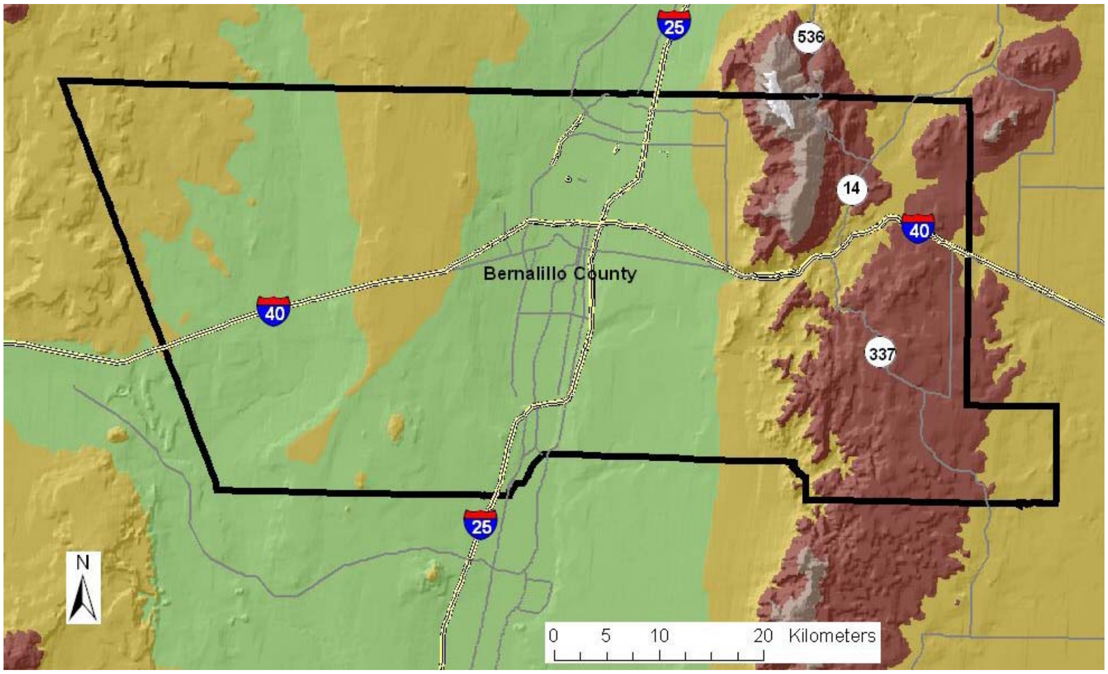


Figure 1-1 Geographic area of emission inventory

1.5 Temporal Resolution

Annual estimates of PM_{10} and ammonia in tons per year are estimated in this inventory.

2. INVENTORY METHODS

2.1 Data Collection Methods

At the beginning of the project a list of candidate spatial and non-spatial databases were identified. The majority of the databases were available on publicly accessible web and ftp sites such as managed by Bernalillo County, the City of Albuquerque and the USGS. Priority was given to those databases with adequate documentation or metadata that address map projection, scale, dates of applicability, and descriptions of data fields. If multiple sources of a thematic database were available, an assessment was made to acquire the best available data considering what organization created the data, documentation, its age, spatial resolution, and spatial extent. Documentation must exist for data and may be acceptable in the form of metadata, a report, published paper or text file. For GIS data the preferred formation for metadata will be one that follows either the Federal Geographic Data Committee (FGDC) or ISO metadata standards. All acceptable metadata standards include the FGDC in ESRI format, FGDC in FAQ format, FGDC in "Geography Network" format, ISO, and ISO in "Geography Network" format.

For data with a spatial component the documentation must include a description of the coordinate system. This description will include information on:

- projection (geographic, UTM, state plane, etc.)

- units (meters, feet, decimal degrees, degrees-minutes-seconds, etc.)
- datum (NAD27, NAD83, WGS84, HARN, etc.)
- spheroid (Clarke1866, GRS80, etc.);

The primary projection of the GIS data is in UTM zone 13, with horizontal units in meters with the NAD83 datum. With the exception of the local aerial photos, all local data was projected into UTM for use in the GIS. Most of the local data had the State-Plane-feet projection in NAD83 datum. Other projections may be used as needed to perform special processing. Metadata was generated using ArcGIS metadata creator and using the FGDC form for both text and XML.

The primary wildfire inventory database was acquired from the Climate, Ecosystem and Fire Applications (CEFA) group at DRI. This database represents an integration of wildfire locations from the US Forest Service's National Interagency Fire Management Integrated Database and the Department of Interior's Shared Applications Computer System at the National Interagency Fire Center. The CEFA group performed a coarse assessment and created data flags to indicate data integrity.

Digital landuse files were acquired from the USGS website in 30-meter spatial resolution. ArcInfo GIS software was used to process the raw files downloaded from the USGS website and format it for use in generating maps. Macro files were used to merge smaller files into one file containing data for that state of NM. A standardized legend that was previously created was applied to this project for consistency.

Political boundaries and street centerlines were obtained from Bernalillo county's GIS data archive, ftp://ims.bernco.gov/pub/trans/. These were compared to the US Bureau of Census 2000 political boundary and street center line data acquired through the ESRI website: http://www.esri.com for consistency. This data traces directly from the US Census Bureau's TIGER® data but translated into ESRI's shapefile format.

One foot pixel resolution natural color digital orthorectified imagery (orthoimagery) for 2004 was obtained from the Bernalillo County GIS ftp site, ftp://ims.bernco.gov/pub/sid/04sid/. This imagery database covers Bernalillo County and parts of Valencia, Sandoval, Santa Fe, and Torrance Counties, New Mexico and was collected by Bohannan Huston, Inc for the county. This dataset served as locating fugitive dust sources such as construction sites, unpaved roads and tilled fields across the county. It also was used as a tool to plan out site visits to verify activity levels. Landsat Thematic Mapper (TM) imagery was acquired from the NASA GeoCover website https://zulu.ssc.nasa.gov/mrsid/mrsid.pl. This imagery serves as a useful qualitative base map that shows how soils, urban areas, and water vary of the earth. This dataset is provided in three spectral bands and provided with a 28.5-m pixel size. The use of the three bands, particularly band 4, emphasizes vegetation as various shades of green.

Four site visits were conducted during the period of developing this emissions inventory with the purpose of verifying activity levels and locations. Digital photos, GPS coordinates and notes on the activity were taken during site visits. Sites visited included agricultural areas and open lots in the South Valley, unpaved roads and trails in the East Mountains and Northeast Heights, and construction sites on the West Mesa. Appendix A shows some of the locations surveyed during the site visits.

2.2 Emission Inventory Development

The majority of the emission factors used in this inventory were based on USEPA's AP-42 if available. USEPA's AP-42 document is a catalog of emission factors for most major sources of criteria pollutants (U.S. EPA, 2004). AP-42 is intended to provide guidance to the creation of emission inventories when better emissions data are not available. All of the emissions calculations, data analysis and graphing were done using MS Excel. For those emission factors that are not included in AP-42 an appropriate model was selected based on recommendations from the WRAP, published articles and the availability of local data for inputs.

For wind erosion, since there is no AP-42 for open range land, we employ a recommendation from the WRAP Fugitive Dust Handbook to use the wind erosion equation. This is summarized in section 4.9 of this report.

2.3 Data Management and Quality Assurance

As part of the quality assurance process we closely examined all databases for this project to determine the validity of the data and whether individual database entries can be included as part of the emissions calculation. Since there were some field data collected to verify source activity levels and locations, an assessment of field data quality was performed after collection of the data from field data staff. Informal assessments of data were performed by inspection of the databases and maps as they were produced.

Data collected as part of this project will be stored on a networked PC server with regular back-ups to minimize data loss in case of hard drive failure or user error. Most data sets will be archived on either CD-ROM or DVD disks as a backup, depending on file size. GIS data, emission calculation files and other databases will be stored using a standard directory and file naming structure. Data collected for this project will be accessible to all DRI project staff members using a local area network of PCs at DRI.

3. MOBILE SOURCE PM_{10}

Mobile sources consist of on-road and non-road (or, off-road) sources. Mobile sources contribute significantly to air pollution emissions, particularly with respect to oxides of nitrogen (NO_x) and volatile organic compounds (VOCs). In 2001, on-road and off-road mobile sources contributed to about 55% of the NO_x emissions and about 44% of the VOC emissions in the United States (US) (USEPA, 2001). They, however, formed only 2.3% of the PM_{10} emissions in the US. In Bernalillo County, historical data indicates that the mobile sources contributed to approximately 1% of the countywide PM_{10} emission inventory (USEPA, 2001).

3.1 MOBILE6 and NONROAD2005 Models

This section gives a short overview of the MOBILE6 and NONROAD2005 models. These models have been developed to aid the user community in estimating emissions from on-road and non-road mobile sources respectively. The models require inputs that are specific to a region. In the absence of locality specific data, the models have national default values that could be used.

3.1.1 MOBILE6 Model

The MOBILE6 model (USEPA, 2003) estimates emission factors of VOCs, carbon monoxide (CO), NO_x, exhaust PM, tire wear and brake wear PM, sulfur dioxide (SO_2), ammonia (NH_3), six hazardous air pollutants (HAPs), and carbon dioxide (CO_2) for gasoline-and diesel highway (on-road) vehicles. It also has the capability to model natural-gas-fueled or electric vehicles. The model accounts for different driving cycles (interstate, freeway on and off ramps, arterials, including collectors and local). More information on the model and how it may be used for emission inventory purposes may be obtained from USEPA (2003, 2004). In order to aid the discussion in this report, Table 3.1 summarizes the MOBILE6 vehicle types and their description.

Table 3.1. MOBILE6 Vehicle Classes

Vehicle Code	Abbreviation	Vehicle Class Description*
1	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
2	LDGT1	Light-Duty Gasoline Trucks 1 (0-6000 lbs GVWR, 0-3750 lbs, LVW)
3	LDGT2	Light-Duty Gasoline Trucks 2 (0-6000 lbs, GVWR, 3751-5750 lbs LVW)
4	LDGT3	Lgiht-Duty Gasoline Trucks 3 (6001-8500 lbs, GVWR, 0-5750 lbs ALVW)
5	LDGT4	Lgiht-Duty Gasoline Trucks 4 (6001-8500 lbs, GVWR, greater than 5751 lbs ALVW)
6	HDGV2b	Heavy-Duty Gasoline Vehicles, Class 2B (8501-10000 lbs GVWR)
7	HDGV3	Heavy-Duty Gasoline Vehicles, Class 3 (10001-14000 lbs GVWR)
8	HDGV4	Heavy-Duty Gasoline Vehicles, Class 4 (14001-16000 lbs GVWR)
9	HDGV5	Heavy-Duty Gasoline Vehicles, Class 5 (16001-19500 lbs GVWR)
10	HDGV6	Heavy-Duty Gasoline Vehicles, Class 6 (19501-26000 lbs GVWR)
11	HDGV7	Heavy-Duty Gasoline Vehicles, Class 7 (26001-33000 lbs GVWR)
12	HDGV8a	Heavy-Duty Gasoline Vehicles, Class 8A (33001-60000 lbs GVWR)
13	HDGV8b	Heavy-Duty Gasoline Vehicles, Class 8B (>60000 lbs GVWR)
14	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
15	LDDT12	Light-Duty Diesel Trucks 1 and 2 (0-6000 lbs GVWR)
16	HDDV2b	Heavy-Duty Diesel Vehicles, Class 2B (8501-10000 lbs GVWR)
17	HDDV3	Heavy-Duty Diesel Vehicles, Class 3 (10001-14000 lbs GVWR)
18	HDDV4	Heavy-Duty Diesel Vehicles, Class 4 (14001-16000 lbs GVWR)
19	HDDV5	Heavy-Duty Diesel Vehicles, Class 5 (16001-19500 lbs GVWR)
20	HDDV6	Heavy-Duty Diesel Vehicles, Class 6 (19501-26000 lbs GVWR)
21	HDDV7	Heavy-Duty Diesel Vehicles, Class 7 (26001-33000 lbs GVWR)
22	HDDV8a	Heavy-Duty Diesel Vehicles, Class 8A (33001-60000 lbs GVWR)
23	HDDV8b	Heavy-Duty Diesel Vehicles, Class 8B (>60000 lbs GVWR)
24	MC	Motorcycles (Gasoline)
25	HDGB	Heavy-Duty Gasoline Buses (School, Transit and Urban)
26	HDDBT	Heavy-Duty Diesel Transit and Urban Buses
27	HDDBS	Heavy-Duty Diesel School Buses
28	LDDT34	Light-Duty Diesel Trucks 3 and 4 (6001-8500 lbs GVWR)

* GVWR: Gross Vehicle Weight Rating; LVW: Loaded Vehicle Weight; ALVW: Adjusted Loaded Vehicle Weight. For more information, please refer to USEPA (2004)

3.1.2 NONROAD2005 Model

The NONROAD2005 model predicts emissions for all non-road equipment categories with the exception of commercial marine vessels, locomotives, and aircraft emissions. The model includes more than 260 specific types of non-road equipment, and classified equipments by horsepower rating and fuel type. Fuel types modeled include gasoline, diesel, compressed natural gas (CNG), and liquefied petroleum gas (LPG). The model directly estimates emissions, in tons, for VOCs, NO_X, CO, CO_2, sulfur oxides (SO_X), and PM. The model includes activity factors and growth and scrappage rates for all equipments and is capable of modeling a specific region, including a sub-county level.

3.2 Estimation of On-road Mobile Source Emissions

Emissions from on-road mobiles sources were developed using the MOBILE6 model, version 6.2.03, dated September 2003. Annual average and typical summer day emissions were estimated for the base year of 2004, as part of this work. Summer day emissions were defined as the average of daily emissions in June, July and August.

3.2.1 Input Parameters

MOBILE6 requires different parameters as input, such as the calendar year, the month of evaluation, minimum and maximum temperatures, absolute humidity etc. Where possible, locality specific data were used. In the absence of local data, national default values were used. For this work, locality specific inputs were used for

- Minimum and Maximum Temperature
- Absolute Humidity
- Fuel Reid Vapor Pressure (RVP) for each Month
- Oxygenated Gasoline Parameters
- Diesel Sulfur Content
- Daily Vehicle Miles Traveled (DVMT)
- Average Vehicle Speed
- Inspection and Maintenance (I/M) program and Anti-Tampering Program (ATP) Parameters

National default values were used for all the other parameters.

Input files were created for each month and were run using the MOBILE6 model. The calculated monthly emissions were summed to determine the annual emissions. Summer emissions were obtained by averaging emissions in June, July and August. More information on the calculation procedure is presented in a later section.

The different input parameters and reasons for the choice of respective values are discussed below.

3.2.2 Calendar Year of Evaluation

The calendar year of evaluation refers to the year for which the emission factors are calculated. This command, along with the evaluation month command, indirectly affects the vehicle fleet composition, if the user wishes to model any of the months of October through December of a calendar year. To take into account of the fact that the newer model vehicles of the upcoming year are released into the market in October of the current year (for example, for the calendar year of 2004, newer 2005 model year vehicles are released into the market in October of 2004), the technical guidance (USEPA, 2004) suggests using (calendar year + 1) along with the "January" option for the evaluation month. Since emissions were estimated for each month in 2004, this guidance was followed.

3.2.3 Month of Evaluation

The MOBILE6 model has the option to model for either January (1) or July (7). For PM inventory, the technical guidance (USEPA, 2004) suggests estimating emissions for the two months and then interpolating for other months. Alternatively, it suggests estimating emissions for each month of the calendar year and summing them to obtain the annual emissions. This was the approach followed in the estimation of the National Emissions Inventory (NEI) for 2002 (Pechan and USEPA, 2005). Since the objective of this work was to develop an annual and typical summer day emission inventory, emissions were estimated for each month in 2004. Table 3-2 summarizes the values used as inputs to the model.

Table 3-2. Calendar Year and Month of Evaluation Inputs to MOBILE6

Month/Year of Emissions	Inputs to MOBILE6 Model	
	Calendar Year	Month of Evaluation
Jan-04	2004	1
Feb-04	2004	1
Mar-04	2004	1
Apr-04	2004	7
May-04	2004	7
Jun-04	2004	7
Jul-04	2004	7
Aug-04	2004	7
Sep-04	2004	7
Oct-04	2005	1
Nov-04	2005	1
Dec-04	2005	1

3.2.4 Environmental Data

Altitude

Counties above approximately 4000 feet MSL should be modeled as high altitude areas. Consistent with approach used in NEI 2002 (Pechan and USEPA, 2005), Bernalillo County, NM, was modeled as a high altitude area.

Minimum and Maximum Temperatures

Average minimum and maximum temperatures for each month in 2004 were obtained from the National Climatic Data Center (NCDC) for the Albuquerque International Sunport Airport at Albuquerque, NM (NCDC, 2005). These values are listed in Table 3-3.

Absolute Humidity

The technical guidance (USEPA, 2004) suggests that the input for absolute humidity should be the lowest humidity ratio that occurred during the exceedance day. This is suggested so as to avoid any unreasonable values of relative humidity (RH, > 100%) calculated within the model for the combinations of temperature and absolute humidity values, given as inputs into the MOBILE6 model. For more generic modeling, monthly and annual averages have been used (Yun, 2004; Cooper and Arbrandt, 2004)). Since the lowest RH typically occurs at the point of maximum daily temperature, the approach followed in this report consisted of calculating the absolute humidity for the combination of average monthly maximum temperature and minimum RH, similar to the approach followed by Davis et al. (2002). These are shown in Table 3-3. The values were similar to the absolute humidity calculated for the combination of monthly mean temperature and mean RH. Absolute humidity values were calculated using the spreadsheet program available at the EPA MOBILE6 website (http://www.epa.gov/otaq/m6.htm). Monthly maximum temperature (F), minimum RH (%) and barometric pressure (inches Hg) were given as inputs. Barometric pressure and RH values were also obtained from NCDC (2005).

Table 3-3 Monthly Temperature and Absolute Humidity in 2004

Month	Temperature* (F)			Min RH* (%)	Barometric Pressure* (inches Hg)	Absolute Humidity† (grains/lb)
	Max	Min	Average			
Jan	48.4	28.2	38.3	34	24.77	20
Feb	48.2	27.1	37.7	31	24.71	18
Mar	65.3	41.1	53.2	28	24.8	31
Apr	65.7	43.3	54.5	30	24.7	34
May	81.8	54.4	68.1	13	24.71	25
Jun	88.8	61.4	75.1	15	24.75	36
Jul	90.6	65.1	77.9	23	24.81	59
Aug	86.5	62.9	74.7	26	24.84	58
Sep	80.3	57.0	68.7	27	24.8	50
Oct	67.7	45.7	56.7	35	24.75	42
Nov	54.1	35.3	44.7	44	24.79	33
Dec	47.5	26.5	37.0	36	24.83	21
Annual Avg	68.7	45.7	57.2	29	24.77	36

* Obtained from NCDC (2005)
† Calculated using max temperature, min RH and barometric pressure using spreadsheet program at http://www.epa.gov/otaq/m6.htm

3.2.5 Fuel Specifications

Fuel RVP

The gasoline RVP affects the volatility of the fuel and is a required input to the model. It typically affects emissions of VOCs. Depending on whether the region is in attainment of the ozone standard or not, federal regulations may restrict the maximum RVP of the fuel sold in a geographic area. Although RVP does not affect PM emissions, attempts were made to use values close to reality. Several sources were referred to in determining what values should be used for each month in 2004. The Code of Federal Regulations (CFR, 2004) specifies controls on fuel volatility for the months of May through September. In addition, the handbook of the

American Society for Testing and Materials (ASTM, 2002) was referred to, for RVP requirements for the whole year. For months where ASTM (2002) provided alternate choices, the higher of the two values were used. Table 3-4 lists the gasoline RVP values used as inputs to the model.

Table 3-4 Gasoline RVP Values used as Inputs to MOBILE6 Model

Month	Gasoline RVP (psi)
January	15.0
February	13.5
March	13.5
April	11.5
May	9.0
June	9.0
July	9.0
August	9.0
September	9.0
October	11.5
November	13.5
December	13.5
Annual Average	11.4

Oxygenated Fuel

The addition of oxygenates to fuel aid in reducing VOC and carbon monoxide (CO) emissions. Hence, oxygenated fuels are required in regions that have been/are non-attainment of CO ambient standard. USEPA (2005a) lists the Albuquerque Metropolitan Statistical Area (MSA) as requiring oxygenated gasoline (100% ethanol blend) from November through February, with a minimum of 2.7% oxygen content. Information collected by the City of Albuquerque (COA) (Personal Communications with Eric Eklund, 2005) indicated similar values (2.7% oxygen content, 8% ethanol by volume). Moreover, it was known that Giant Industries typically added oxygenates throughout the year, while some others do only during the required period. Hence, it appears that the percent of oxygenated fuel in the market during the non-winter period may vary. The New Mexico Department of Agriculture (NMDA) conducts selected testing of fuel in response to complaints or as part of random quality checks. Data obtained from NMDA for the year 2004 (Personal Communications with Mike Steffey, 2006) included information on the percent of ethanol in the fuel for each month in 2004. The data suggested that, of the fuels tested, the fraction of gasoline containing more than 2% (arbitrarily chosen basis) ethanol dropped from more than 90% (November to February) to ~50% (March and October) and to less than 10% during other months. The data from NMDA, while not covering all gasoline stations in the area, is a random testing of the population of fuel stations in the County in 2004. Hence, based on the information gained from the different sources, the following assumptions were used in modeling oxygenated fuel program in Bernalillo County in 2004:

- % of Market Share that is alcohol blend:
    - 100% for Nov, Dec, Jan, Feb
    - 50% for Mar and Oct

    - 0% for Apr through Sep
- Oxygen Content of Ethanol Blend
    - 2.7% oxygen

Gasoline Sulfur Content

The fuel program in Bernalillo County, NM was modeled as "Conventional Gasoline West", which automatically takes into account the phase-in schedule of the Tier2 Sulfur rule in the western states, including New Mexico (USEPA, 2003, 2004).

Diesel Sulfur Content

The diesel sulfur content is a required input to the model for estimation of PM emissions. This parameter has a significant effect on the PM emissions. Several sources were consulted for an appropriate choice of the sulfur content. Personal Communications with Eric Eklund (2005) indicated an average diesel sulfur content of 0.04% (400 ppm) by weight. Data from NMDA (Personal Communications with Mike Steffey, 2006) showed diesel sulfur content to vary from 0.0143% (143 ppm) to 0.0472% (472 ppm) for 2004, with an average of 0.0343% (343 ppm). The MOBILE6 technical guidance (USEPA, 2004) suggests using data assembled by EPA as part of the National Mobile Inventory Model (NMIM), in the absence of any local survey information. The database in the NMIM model (http://www.epa.gov/otaq/nmim.htm) showed highway diesel sulfur content for Bernalillo County to range from 300 ppm to 330 ppm. The comparability of information from the different sources indicate the reliability of the local survey data, and a value of 400 ppm was chosen as the highway diesel sulfur content for all months in 2004.

3.3 Fleet Characteristics and Related Inputs

Average Vehicle Speed

The average speed values by roadway classification were obtained from MRCOG. The model also requires the specification of the roadway type (or the driving cycle) that the speed is representative of. The MOBILE6 model has the following classifications: Non-Ramp, Freeway, Arterial and Areawide. For local roadways and freeway ramps, the model uses default values of 12.9 mph and 34.6 mph respectively. The guidance suggests that arterial/collector driving cycles be used in situations where the local VMT does not match with the driving cycle built into the model for local roadway. The local roadway types had much higher speeds than the 12.9 mph used in the model. Hence they were modeled as arterial. Similarly, the "Rural Major Collector" roadway type had an average speed of 50.8 mph, which is more representative of a non-ramp driving cycle in the model. The final mapping of the actual roadway type with the driving cycles in the model is shown in Table 3-5.

Daily Vehicle Miles Traveled (DVMT)

This represents the total vehicle miles traveled in each vehicle classification in 2004. While these are not direct inputs to the model, these are required to estimate emissions in terms of tons/day using the gram/mile output from the model. These are listed in Table 3-5.

Table 3-5 Average Vehicle Speed and DVMT by Roadway Type and Mapping to MOBILE6 Driving Cycle

County Roadway Type	MOBILE6 Driving Cycle	Average speed (mph)	DVMT (miles/day)
Urban Interstate	Non-Ramp	57.5	4,146,250
Urban Principal Arterial	Arterial	36.5	5,113,890
Urban Major Arterial	Arterial	33.6	1,720,143
Urban Collector	Arterial	34.4	1,302,485
Urban Local	Arterial	20.0	1,389,900
Rural Interstate	Non-Ramp	66.3	633,787
Rural Minor Collector	Arterial	35.0	74,522
Rural Major Collector	Non-Ramp	50.8	157,448
Rural Local	Arterial	25.0	259,530

Seasonal Adjustment Factors (SAF)

The seasonal adjustment factor (SAF) is used to adjust the annual average DVMT to a particular time of the year, to account for the variation in the VMT over different periods of the year. The factors to adjust the annual DVMT to each month of the year, by roadway classification, were obtained from the Mid Region Council of Governments (MRCOG) (Personal Communications with Shohreh Day, 2005). While these are not direct inputs to the model, they are required to estimate emissions for a particular season using the annual DVMT and the MOBILE6 output. The inverse of the seasonal adjustment factors are shown in Table 3-6. The inverse SAF for a time period is multiplied by annual DVMT to estimate the VMT for that particular time period.

VMT Mix and Registration Distribution

The VMT mix represents the fraction of miles accumulated by each vehicle type within a roadway classification. The registration distribution gives a distribution of the age of the vehicle fleet. The MOBILE6 model has default values for both these parameters. However, these two parameters can have a significant impact on the emissions of all pollutants, if they differ widely from the national default fractions. Due to time constraints and data unavailability, national defaults were used for these two parameters.

Table 3-6 Inverse Seasonal Adjustment Factors for DVMT for Bernalillo County in 2004

County Roadway Type	INVERSE SEASONAL (MONTHLY) ADJUSTMENT FACTORS for 2004											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Urban Interstate	0.9337	0.9597	1.0111	1.006	1.0183	1.0299	1.0204	1.0417	1.0256	1.0235	0.956	0.9823
Urban Principal Arterial	0.9833	1.002	1.0235	1.0341	1.0152	1.0331	1.003	1.0204	0.9911	1.001	0.9506	0.9443
Urban Major Arterial	0.9833	1.002	1.0235	1.0341	1.0152	1.0331	1.003	1.0204	0.9911	1.001	0.9506	0.9443
Urban Collector	0.9833	1.002	1.0235	1.0341	1.0152	1.0331	1.003	1.0204	0.9911	1.001	0.9506	0.9443
Urban Local	0.9833	1.002	1.0235	1.0341	1.0152	1.0331	1.003	1.0204	0.9911	1.001	0.9506	0.9443
Rural Interstate	0.9141	0.9025	1.0235	0.9653	1.0121	1.0406	1.0846	1.0256	0.9756	1	0.9901	1.0299
Rural Minor Collector	0.878	0.8889	0.9862	0.9804	1.0277	1.0741	1.1025	1.0695	1.0121	1.0341	0.9862	0.9606
Rural Major Collector	0.878	0.8889	0.9862	0.9804	1.0277	1.0741	1.1025	1.0695	1.0121	1.0341	0.9862	0.9606
Rural Local	0.878	0.8889	0.9862	0.9804	1.0277	1.0741	1.1025	1.0695	1.0121	1.0341	0.9862	0.9606

The registration/age distribution is typically developed from the local county vehicle registration data or from the Inspection and Maintenance (I/M) database. Attempts were made to obtain vehicle registration data. However, due to time constraints, the data was not available to us in time to develop an age distribution. While sample data sets on I/M databases were obtained from the VPMD, the complete database was unavailable within the available time. Even if data from the I/M program were obtained, it would have had to use some assumptions. The best source of the data would be the vehicle registration data.

Discussion with MRCOG (Personal Communications with Nathan Masek, 2006) indicated that the VMT fraction data was unavailable. While MRCOG has raw vehicle counts by vehicle classification, the data has not been processed to yield VMT fractions. MRCOG suggested that the truck traffic on the interstates in this County were as high as 40% (Personal Communications with Masek, 2006). National default values in the model apply ~ 5% of the VMT to HDDV (8A+8B category). The vehicle fraction is different from VMT fraction due to differential mileage accumulation rates of the different vehicle classes. Even otherwise, this difference may potentially underestimate the emissions from HDDV in Bernalillo County.

3.3.1 Inspection and Maintenance Program and Anti-Tampering Program (ATP)

Bernalillo County, NM, had an I/M program and an ATP in place during the year 2004. The details on the I/M program were obtained by telephonic conversation with personnel at Vehicle Pollution Management Division (VPMD) of COA (Personal Communications with Ron Latimer, 2005; Personal Communications with Glen Dennis, 2005). In addition, details were provided on the assumptions used by COA in their modeling (Lehner, 2004; Summers, 2005; Personal Communications with Stephanie Summers, 2005; Personal Communications with Fabian Macias, 2005).

Most assumptions used by COA and specified in Lehner (2004) and Summers (2005) were retained in this work. The changes that were made are discussed below. Discussions with personnel at VPMD of COA indicated that the On-board Diagnostics (OBD) I/M program was not in place until July 2004, until which point the vehicles were tested using idle I/M program. Hence the OBD I/M program was modeled only for months July through December of 2004. In addition, the input files used by COA showed all gasoline vehicles of Gross Vehicle Weight (GVW) of 26,000 lbs (HDGV6 vehicle class) or less as being subjected to I/M. However, discussions with VPMD and reference of New Mexico Air Quality Control regulations (NMAC 2004) suggested that only vehicles up to 10,000 lbs (HDGV2B) or less were subject to I/M. While the input files from COA showed grace period to be 1 year, NMAC (2004) regulations mention that a vehicle is exempt from I/M for two registration periods (indicating a grace period of 2 years). Hence, changes were made to reflect these corrections.

3.4 Model Runs and Emission Calculations

Input files were created for each month in 2004 as described in this document. The input files are presented as electronic files. Each input file consists of a header section, a run section and 13 scenario sections. The nine roadway types shown in Table 3-5 were modeled as nine different scenarios in each input file. The MOBILE6 technical guidance suggests using 8% of the total DVMT on interstates as ramp VMT and the rest 92% as interstate/freeway VMT.

Hence, two additional scenarios were included that modeled urban and rural interstate ramps. However, since the source classification codes (SCC) do not separate out ramps from interstates, the final emissions from interstates and ramps were summed to obtain the total interstate emissions. A comparison between using ramps and not using ramps, showed negligible difference in emissions. Hence, although the input files contained 11 scenarios, only 9 scenarios were used in emission calculations.

3.4.1 Emission Calculation Methodology

The results from the MOBILE6 model are grams of pollutant per mile of travel. The emission factors were then multiplied by the DVMT to obtain emissions in units of mass/day (e.g. tons per day). The baseline year calculations were done for 2004. The emissions for each month were calculated as follows:

$$EM_{rv} = (EF_{rv}) * DVMT_r * VMTF_{vr} * SAF_r * N / 907200$$

Where,

EM_{rv} = emissions by roadway type (9 classes excluding ramps) and vehicle type (28 vehicle types), tons/month

EF_{rv} = emission factor from MOBILE6 model run, by roadway and vehicle type, g/mile

$DVMT_r$ = annual average daily vehicle miles traveled by roadway classification

$VMTF_{vr}$ = VMT fraction of each vehicle type within each roadway classification

SAF_r = inverse seasonal adjustment factor for DVMT by roadway classification

N = number of days in each month

907200 = conversion factor to convert mass units from grams to tons.

Using the above equation, emissions were calculated for each roadway (9 classes excluding ramps) and vehicle type (28 vehicle types) combination for each month. The composite countywide emission is the sum of emissions by roadway type and vehicle type, from all the MOBILE6 runs.

For calculating annual emissions, the emissions for each month (tons/month) were added together to obtain the annual emissions in tons per year (tons/yr). Typical summer day emissions were calculated by adding emissions in June, July and August followed by division by the total number of days in these three months (92 days) to obtain the emissions in tons per day (tons/day).

3.5 Assignment of Source Classification Codes (SCC)

The emissions calculated for each combination of the 9 roadway classes (excluding ramps) and 28 vehicle types were allocated to an appropriate SCC. The SCCs were based on the latest listing posted by EPA as of February 2004 (http://www.epa.gov/ttn/chief/codes/index.html).

The 28 vehicle types were condensed to 12 vehicle types to match the SCC vehicle grouping. In this case, emissions from all vehicles constituting a particular SCC vehicle group were added together to obtain a single emission corresponding to the SCC vehicle group. For example, emissions from LDGT1 and LDGT2 were added to obtain emissions for LDGT12 category. The SCC had 12 roadway types, while the County had 9 roadway classes. For those roadways not present in the County, the particular SCCs were not used. Table 3-7 shows how the 28 MOBILE6 vehicle classes were condensed to 12 SCC vehicle groups. Table 3-8 summarizes how the 9 roadway types in the County were mapped to the corresponding group in the SCC.

3.6 Discussion of Results

Total countywide annual PM_{10} emissions in Bernalillo County in 2004 were 367 tons/yr. Typical summer day emissions were 1.03 tons/day. Table 3-9 summarizes the annual PM_{10} emissions, in tons/yr, by vehicle class and roadway type, as per the SCC grouping. Table 3-10 summarizes the emissions for a typical summer day, expressed in lbs/day.

Figure 3-1 shows a plot of the emissions by roadway and vehicle type, summarized by major classes. Figure 3-2 and Figure 3-3 present the data in the form of a pie chart showing the distribution of emissions within each vehicle and roadway class. It is obvious that the HDDV contribute to 55% of the annual PM_{10} emissions, followed by the light duty cars and trucks. Within the HDDV category, the classes HDDV8A and 8B together contribute about 71% of the emissions. These two classes represent the long-haul heavy-duty diesel tractor-trailers. The majority of emissions occurred on urban arterials (45%) and interstates (28%). Since the runs utilized national default VMT fractions, which do not differ between the roadway classes, the main reason for concentration of emissions on these two roadways is due to the fact that a majority of the VMT (63% of County VMT) occurs on these two roadway classes.

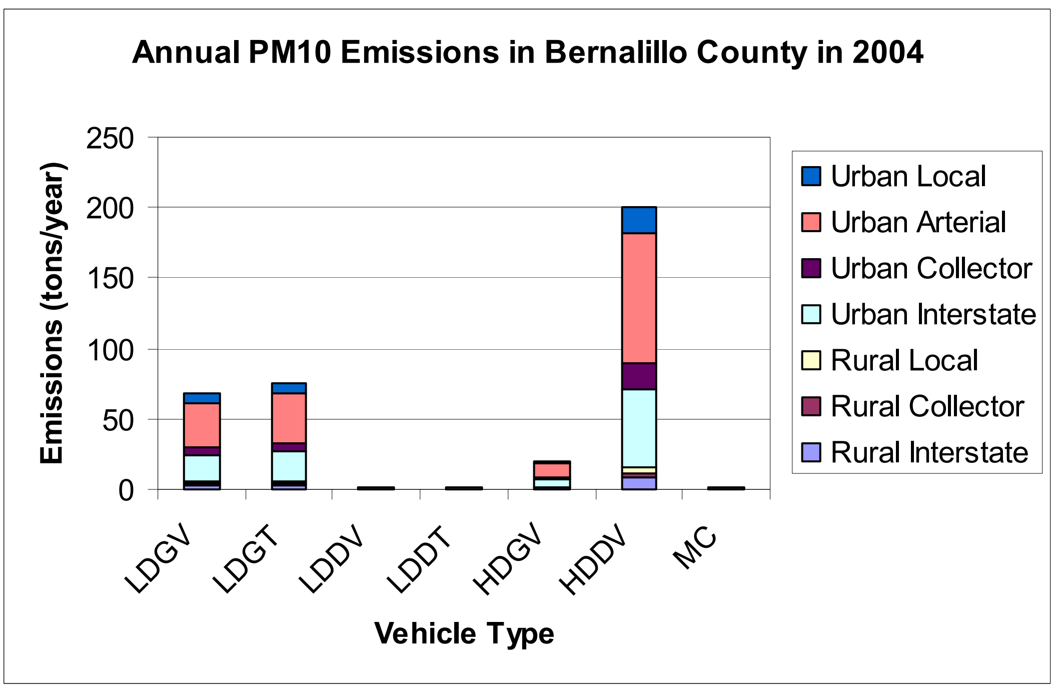


Figure 3-1 Annual PM_{10} Emissions in Bernalillo County in 2004 by Roadway and Vehicle Type

Table 3-7. Vehicle Class Mapping between MOBILE6 Class and SCC Grouping

MOBILE6 Vehicle Class	SCC Vehicle Grouping
LDGV	LDGV
LDGT1	LDGT12
LDGT2	
LDGT3	LDGT34
LDGT4	
HDGV2B	HDGV
HDGV3	
HDGV4	
HDGV5	
HDGV6	
HDGV7	
HDGV8A	
HDGV8B	
HDGB	
LDDV	LDDV
LDDT12	LDDT
LDDT34	
HDDV2B	HDDV2B
HDDV3	HDDV345
HDDV4	
HDDV5	
HDDV6	HDDV67
HDDV7	
HDDV8A	HDDV8AB
HDDV8B	
MC	MC
HDDBT	HDDBST
HDDBS	

Vehicle codes with combined letters indicate the composite of the constituent vehicle classes. For example, LDGT34 consists of LDGT3 and LDGT4.

Table 3-8. Roadway Class Mapping between County Roadway Class and SCC Roadway Grouping

County Roadway	SCC Roadway Grouping
Rural Interstate	Rural Interstate
	Rural Other Principal Arterial
	Rural Minor Arterial
Rural Major Collector	Rural Major Collector
Rural Minor Collector	Rural Minor Collector
Rural Local	Rural Local
Urban Interstate	Urban Interstate
	Urban Other Freeways and Expressways
Urban Principal Arterial	Urban Other Principal Arterial
Urban Major Arterial	Urban Minor Arterial
Urban Collector	Urban Collector
Urban Local	Urban Local

Empty roadway class indicates absence of that roadway type in the County.

Table 3-9. Annual PM_{10} Emissions in Bernalillo County in 2004 by Vehicle Class and Roadway Type (tons/yr)

	Emissions by Vehicle Class (tons/yr)												
Roadway Type	**LDGV**	**LDGT12**	**LDGT34**	**HDGV**	**LDDV**	**LDDT**	**HDDV2B**	**HDDV345**	**HDDV67**	**HDDV8AB**	**HDDBST**	**MC**	**Grand Total**
Rural Interstate	2.871	2.334	0.8485	0.8644	0.03420	0.08867	0.4224	0.2811	1.307	6.035	0.5178	0.0552	15.7
Rural Major Collector	0.7152	0.5815	0.2114	0.2154	0.00853	0.02210	0.1052	0.0700	0.3255	1.503	0.1290	0.0138	3.90
Rural Minor Collector	0.3385	0.2752	0.1001	0.1019	0.00404	0.01046	0.0498	0.0331	0.1541	0.7116	0.06106	0.0065	1.85
Rural Local	1.219	0.9741	0.3526	0.3526	0.0141	0.03642	0.1734	0.1154	0.5366	2.478	0.2127	0.0229	6.49
Urban Interstate	18.85	15.32	5.569	5.674	0.2249	0.5825	2.773	1.845	8.578	39.62	3.400	0.3623	103
Urban Principal Arterial	23.23	18.88	6.862	6.995	0.2777	0.7185	3.419	2.275	10.58	48.86	4.191	0.4465	127
Urban Major Arterial	7.845	6.366	2.310	2.351	0.09342	0.2417	1.150	0.7651	3.557	16.43	1.410	0.1502	42.7
Urban Collector	5.929	4.820	1.748	1.781	0.07074	0.1830	0.8709	0.5793	2.694	12.44	1.067	0.1137	32.3
Urban Local	6.633	5.269	1.898	1.881	0.07549	0.1953	0.9293	0.6182	2.874	13.28	1.139	0.1227	34.9
Grand Total	67.6	54.8	19.9	20.2	0.803	2.08	9.89	6.58	30.6	141	12.1	1.29	367

Table 3-10. Typical Summer Day PM_{10} Emissions in Bernalillo County in 2004 by Vehicle Class and Roadway Type (lbs/day)

	Emissions by Vehicle Class (lbs/day)												
Roadway Type	**LDGV**	**LDGT12**	**LDGT34**	**HDGV**	**LDDV**	**LDDT**	**HDDV2B**	**HDDV345**	**HDDV67**	**HDDV8AB**	**HDDBST**	**MC**	**Grand Total**
Rural Interstate	16.543	13.39	4.902	5.002	0.2075	0.5202	2.436	1.620	7.518	34.82	2.982	0.320	90.26
Rural Major Collector	4.234	3.426	1.255	1.280	0.0531	0.1331	0.623	0.415	1.924	8.91	0.763	0.082	23.10
Rural Minor Collector	2.004	1.622	0.594	0.606	0.0251	0.0630	0.295	0.196	0.911	4.22	0.361	0.039	10.93
Rural Local	7.218	5.750	2.089	2.096	0.0875	0.2194	1.028	0.684	3.172	14.69	1.258	0.136	38.43
Urban Interstate	106.2	85.94	31.47	32.11	1.332	3.339	15.64	10.40	48.26	223.6	19.14	2.054	579.4
Urban Principal Arterial	129.5	104.8	38.36	39.14	1.624	4.071	19.06	12.68	58.83	272.5	23.33	2.504	706.3
Urban Major Arterial	43.71	35.37	12.90	13.15	0.5462	1.369	6.412	4.265	19.79	91.67	7.849	0.842	237.9
Urban Collector	32.97	26.78	9.770	9.969	0.4136	1.037	4.855	3.230	14.98	69.41	5.943	0.638	180.0
Urban Local	36.92	29.30	10.60	10.53	0.4414	1.106	5.181	3.446	15.99	74.07	6.342	0.688	194.6
Grand Total	379.3	306.3	111.9	113.9	4.731	11.86	55.53	36.94	171.4	793.9	67.97	7.304	2061

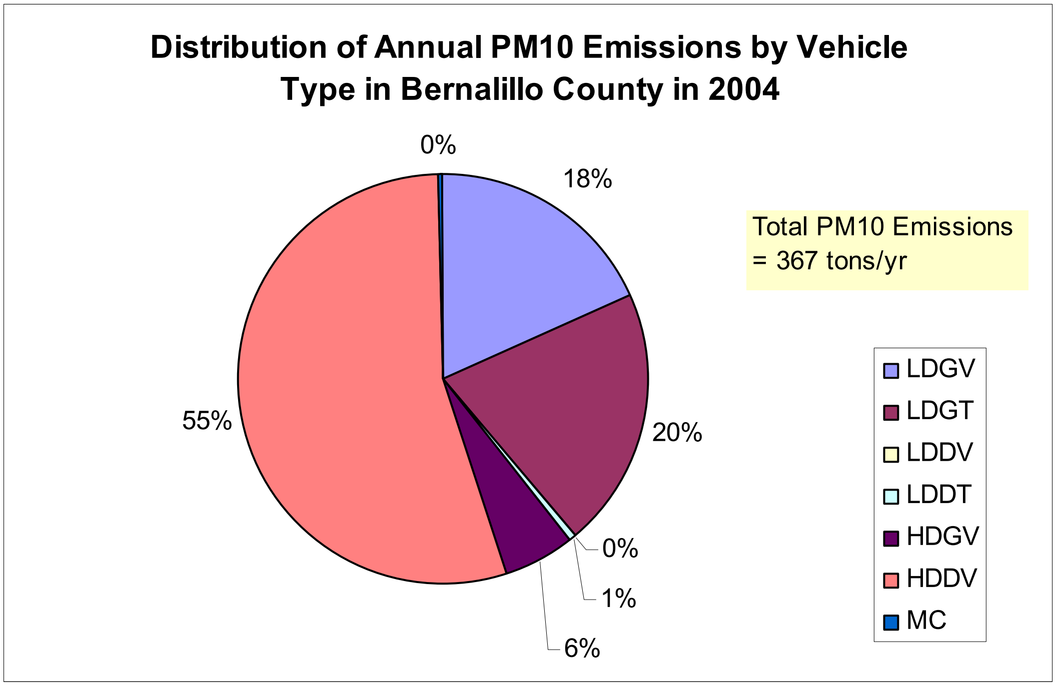


Figure 3-2 **Distribution of Annual PM_{10} Emissions by Vehicle Type in Bernalillo County in 2004**

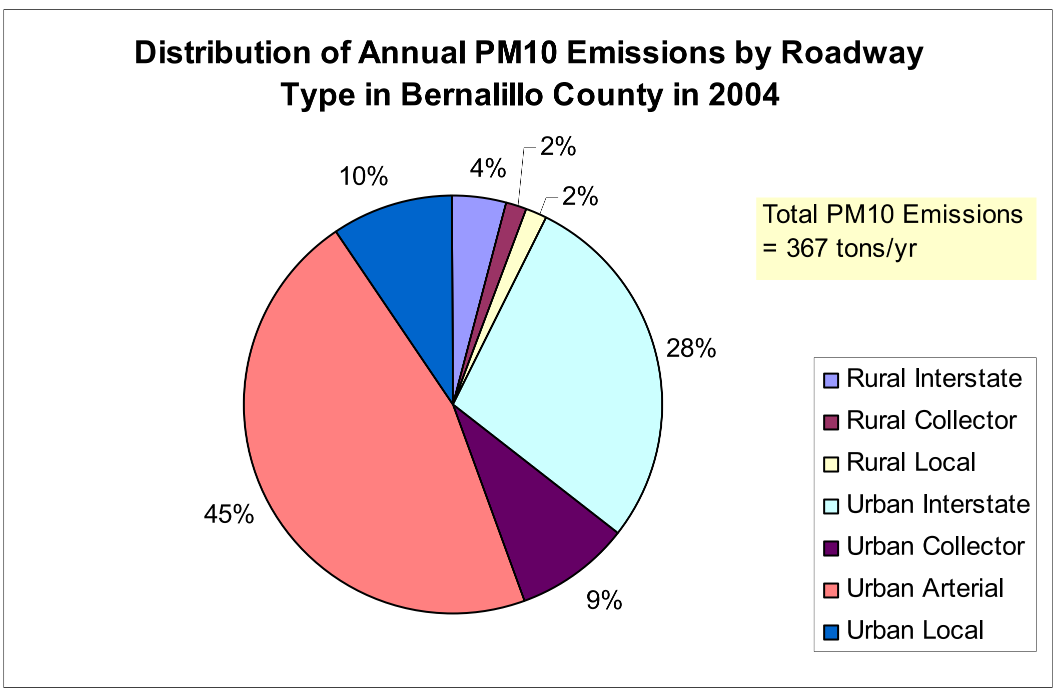


Figure 3-3 **Distribution of PM_{10} Emissions by Roadway Type in Bernalillo County in 2004**

While this depicts the major roadway and vehicle classes, this representation may change if locality specific VMT fractions were used. This illustrates the importance of locality specific VMT fractions by roadway class, which would take into account the different distribution of vehicles between the roadways. For example, the national default VMT fraction assumes that HDDV8B class accumulates ~3.9% of the VMT, regardless of the roadway. Hence, a local roadway and an interstate would, by this definition, have 3.9% of the VMT accumulated by HDDV8B trucks. However, in reality, it is known that the local roadways typically have a larger fraction of passenger cars and trucks (LDGV, LDGT), while the interstate might have a larger fraction of HDDV8B.

3.7 Estimation of Non-Road Mobile Sources

Emissions from non-road mobile sources were estimated using the final NONROAD2005 model released in Dec 2005. Similar to the on-road mobile sources, emissions were estimated for the annual period and for a typical summer day for the base year of 2004.

3.7.1 Input Parameters

The NONROAD2005 model requires certain parameters as locality specific inputs. These include

- Fuel RVP
- Gasoline Oxygen Content
- Gasoline Sulfur Content
- Diesel Sulfur Content
- Marine Diesel Sulfur Content
- CNG/LPG Sulfur Content
- Minimum, Maximum and Average Temperatures

All default activity data in the model were used without modification.

3.7.2 Minimum and Maximum Temperatures

Average minimum and maximum temperatures for each month in 2004 were obtained from the National Climatic Data Center (NCDC) for the Albuquerque International Sunport Airport at Albuquerque, NM (NCDC, 2005). These values are listed in Table 3-11. For the annual calculation, the annual average values were used. For the summer period, the average of June, July and August temperatures were used. Table 3-11 summarizes the values used for the annual and summer season runs.

3.7.3 Fuel Specifications

Gasoline Sulfur and Oxygen Content

The gasoline sulfur content was obtained from the output of the MOBILE6 model runs conducted for the on-road mobile sources. Since the MOBILE6 model automatically takes into account the phase-in schedule of the Tier2 Sulfur rule in the western states, including New Mexico (USEPA, 2003, 2004), this approach was deemed to be reasonably accurate and consistent between the mobile sources. A value of 160 ppm (0.016%) was used and is shown in Table 3-11. This is similar to the data supplied by NMDA (Personal Communications with Mike Steffey, 2006), which indicated gasoline sulfur content to range from 0.0040 to 0.0980%, with an average of 0.0119%.

The oxygen content for the annual period was based on a weighted average of the market share of oxygenated fuel and oxygen content in all months in 2004, using the same basis assumed for the on-road mobile runs. During summer, it was assumed that there was no oxygenated fuel and hence assumed zero oxygen content.

Non-road and Marine Diesel Sulfur Content

Non-road diesel is different from highway diesel in its chemical composition. The data from NMDA (Personal Communications with Mike Steffey, 2006) does not distinguish between on-road and non-road diesel. In the absence of local information, the data in the NMIM model was used. The database in the NMIM model (http://www.epa.gov/otaq/nmim.htm) showed off-highway diesel sulfur content of 2457 ppm and 2765 ppm for marine diesel sulfur for Bernalillo County. These are tabulated in Table 3-11.

Liquefied Petroleum Gas (LPG) / Compressed Natural Gas (CNG) Sulfur Content

Due to lack of local information, the data in the NMIM model was used. The database in the NMIM model (http://www.epa.gov/otaq/nmim.htm) showed CNG/LPG sulfur content of 30 ppm for Bernalillo County (Table 3-11).

3.7.4 Effectiveness of Stage II Controls for Non-Road Equipment

Due to lack of local information, the effectiveness of stage II controls on non-road emissions were assumed to be zero, consistent with the NONROAD model user guide (USEPA, 2005b).

3.8 Model Runs and Emission Calculations

The NONROAD2005 model was run with the inputs described above (and shown in Table 3-11) for the annual and summer periods. The model automatically calculates the emissions in tons per period. Hence, the annual emissions were in tons per year (tons/yr). The summer period emissions were divided by the number of days in June, July and August (92 days) to determine the emissions on a typical day basis (tons/day). The model also automatically assigns SCC to the emissions.

3.9 Addition of Locomotive, Marine Vessels and Aircraft Emissions

The NONROAD 2005 model does not estimate emissions from locomotive engines, commercial marine vessels and aircraft emissions. For these sources, the emissions were imported from the 2002 NEI Draft Non-road inventory, without further adjustments. This was done due to the following reasons: Based on the 2001 PM_{10} emissions inventory for Bernalillo County (USEPA, 2001) the non-road mobile sources accounted for a very minor (~0.5%) of the total countywide PM_{10} emissions. Secondly, time constraints did not allow a detailed evaluation of the activity factors for these sources. Thirdly, the 2002 NEI draft inventory already includes updated activity factors and hence was assumed to be reasonable for our purposes. The sources and associated emissions are shown in Table 3-12.

Table 3-11 Input Parameters for NONROAD Model

Parameter	Annual Emission Inventory	Summer Period Emission Inventory
Gasoline RVP (psi)	11.4	9
Oxygen Content (%)	1.1	0
Gasoline Sulfur Content (%)	0.016	0.016
Diesel Sulfur Content (%)	0.2457	0.2457
Marine Diesel Sulfur Content (%)	0.2765	0.2765
CNG/LPG Sulfur Content (%)	0.003	0.003
Stage II Control (%)	0	0
Minimum Temperature (F)	45.7	63.1
Maximum Temperature (F)	68.7	88.6
Average Temperature (F)	57.2	75.8
Year	2004	2004
Period/Season	Annual	Summer
Emission Type	Period Total	Period Total

Table 3-12 Sources and Emissions not Estimated by NONROAD Model and Imported from NEI 2002 Draft Inventory

SCC	Annual PM_{10} Emissions (tons/yr)	Emission Description
2275001000	7.5196	Military Aircraft
2275020000	22.871	Commercial Aircraft
2275050000	11.677	Aircraft, General Aviation
2275060000	6.373	Aircraft, Air Taxi
2285002006	3.9634	Railroad Equipment, Diesel Line Haul Locomotives: Class I Operations
2285002008	0.26253	Railroad Equipment, Diesel Line Haul Locomotives: Passenger Trains (Amtrak)
2285002010	1.592	Railroad Equipment, Diesel Yard Locomotives

3.10 Discussion of Results

Table 3-13 summarizes the PM_{10} emissions from non-road mobile sources in Bernalillo County in 2004. Figure 3-4 shows a pie chart of the annual PM_{10} emissions from non-road sources in Bernalillo County in 2004. As seen, 46% of the emissions were contributed by construction and mining equipment followed by commercial and residential use of lawn and gardening equipment. The third major category were emissions associated with aircraft.

Table 3-13 Annual (tons/yr) and Summer (lbs/day) PM_{10} Emissions from Non-road Mobile Sources in Bernalillo County in 2004

	PM_{10} Emissions	
Source	**Annual (tons/yr)**	**Summer (lbs/day)**
Agricultural Equipment	1.0	7.3
Aircraft	48.4	263.3
Airport Equipment	4.1	22.4
Commercial Equipment	26.4	143.6
Construction and Mining Equipment	165.7	981.7
Industrial Equipment	20.3	111.5
Lawn and Garden Equipment	78.4	494.8
Logging Equipment	0.01	0.07
Pleasure Craft	0.7	7.1
Railroad Equipment and Locomotives	5.9	32.2
Recreational Equipment	7.4	59.5
Total	358.5	2124

PM_{10} emission inventory was developed for on-road and non-road mobile sources. Annual average emissions were 367 tons/yr and 359 tons/yr from on-road and non-road mobile sources respectively. On-road mobile source emissions were dominated by HDDV followed passenger cars and trucks. Emissions from construction equipment, lawn and gardening equipments and aircrafts were the major sources within the non-road mobile category.

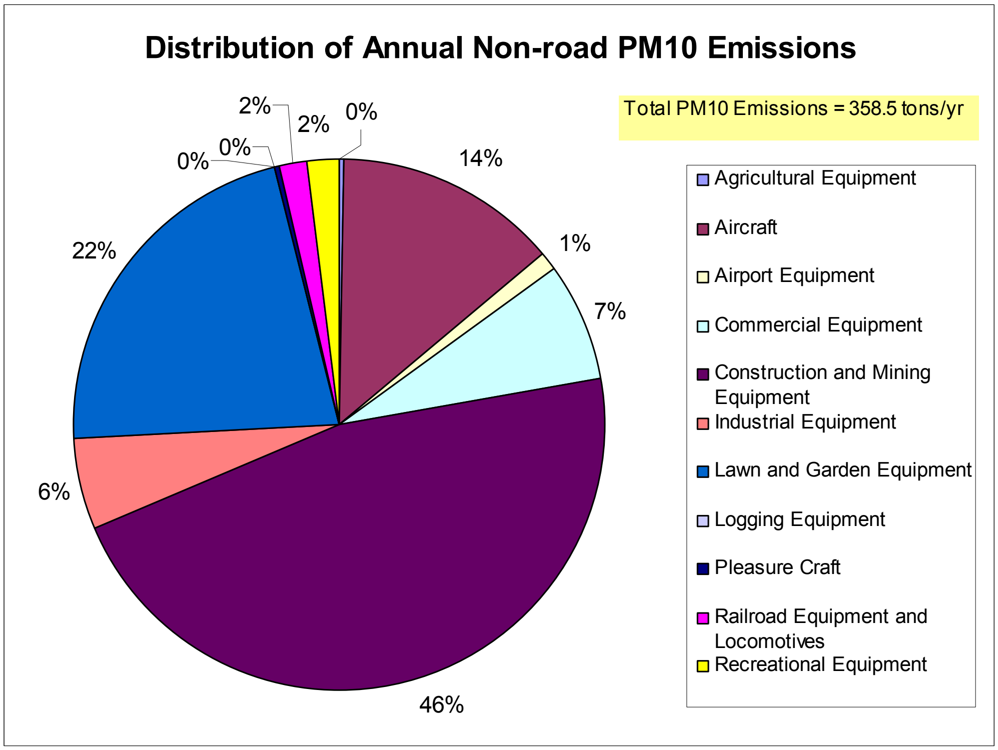


Figure 3-4 Distribution of Annual Non-road PM_{10} Emissions by Source in Bernalillo County in 2004

4. AREA SOURCE PM_{10} EMISSIONS

4.1 Biomass Burning

4.1.1 Wildfires and Prescribed Burning

Fire activity levels were obtained from the COA open burn database for 2005 as well as based on calculations from the green house gas inventory of 2005. This year was used rather than 2004 since the open burn database was more complete and would offer a better representation of burns over an annual cycle.

Fuel loads (tons/acre) are obtained from WRAP 2002 Smoke Emissions Inventory. Conversion factors of cubic feet to pounds are retrieved from Waste Prevention, Recycling, and Composting Options: Lessons from 30 U.S. Communities, Portland, OR conversion factor in Appendix C. Emission Factors for New Mexico were obtained from WRAP 2002 Smoke Emissions Inventory.

Table 4.1-1 Conversions between fuel loading and tons

Estimation of Loads (in tons)	Volume (ft^3)	acres	ft^3 to tons	acres to tons	Load (tons)
Wildfires		57.9		260.6	260.55
Yard Waste (Grass/weeds)	8975	10	41.6	32.0	73.55
Agricultural burns (Grass/weeds	1500	51.5	6.9	164.8	171.74
Agricultural burns (Wood/leaves)	1000		6.7		6.74
Pine forest		70		315.0	315.0

Table 4.1-2 Annual PM_{10} emissions from wildfire and prescribed burning in Bernalillo County in 2005

Type		Load (in tons)	EF (lbs/ton)	PM_{10} emissions (in tons)
Wildfires		260.55	28.1	3.7
Prescribed	Yard Waste (Grass/weeds)	73.55	31.8	1.2
	Agricultural burns (Grass/weeds	171.74	28.1	2.4
	Agricultural burns (Wood/leaves)	6.74	31.8	0.1
	Pine forest	315	31.8	5.0
Total				**12.4**

4.1.2 Residential Wood Burning

Based on Table 4.1-3, the heating degree days using 65 ^oF as the base temperature is 4354 based on the temperature data from the Albuquerque International Airport station. This puts in the Albuquerque area into climate zone 3, which means 50% the wood burning activity is in the winter, 25% in both spring and fall. For this inventory we assume that all of Bernalillo County is in the same climate zone.

Table 4.1-3 Period of Record (1914 to 2004) General Climate Summary - Heating Degree Days at the Albuquerque Airport weather station.

Heating Degree Days for Selected Base Temperature (F)													
Base Temperature (F)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
65	922	693	565	294	83	4	0	0	24	242	626	899	4354
60	767	552	412	169	32	1	0	0	7	127	476	744	3286
57	674	467	323	112	16	0	0	0	3	79	387	651	2712
55	612	411	267	82	10	0	0	0	2	55	328	589	2356
50	457	275	147	33	2	0	0	0	1	20	197	435	1567

Heating Degree Day units are computed as the difference between the base temperature and the daily average temperature (e.g. Base Temp. - Daily Ave. Temp.). One unit is accumulated for each degree Fahrenheit the average temperature is below the base temperature. Negative numbers are discarded. For example if the days high temperature was 65 and the low temperature was 31, the base 50 heating degree day units is 50 - ((65 + 31) / 2) = 2. This is done for each day of the month and summed. Months with five or more missing days are not considered. Years with 1one or more missing months are not considered.

Based on the U.S. Census Bureau annual estimates of housing units for counties in New Mexico from April 1, 2000 to July 1, 2004 (HU-EST2004-04-35), the number of housing units in Bernalillo County is estimated to be about 259,500 on July 1, 2004.

During the 1998 City of Albuquerque Residential Wood Burning Survey, which is the latest wood burning survey in the area, 1000 households were interviewed on the telephone. Table 4.1-4 summarizes the survey data that was used to estimate the PM_{10} emissions from wood burning in Bernalillo County. Of the 73 wood burning stoves, 20.7% are manufactured after 1990 and certificated by EPA, 1.1% are manufactured after 1990 without EPA certification, and 78.2% are manufactured before 1990 and are probably not EPA certified.

According to the survey 2% of the 1000 homes surveyed have a pellet stove. Mean number of days used is 6.3 per week during the winter months. On average, 5 bags (200 pounds) of pellets were burned by each stove during the winter months. Table 4.1-5 lists the parameters used in PM_{10} emission calculation.

Table 4.1-4 Summary of 1998 city of Albuquerque wood burning survey

(Per 1000 homes)	Wood Burning Stove	First Fireplace	Second Fireplace
Number of Units	73	370	30
Never Used	38%	48%	70%
Mean Number of Days Used/Week	3.5	2	1.4
Total Used Days/week	158.6	384.8	12.6
Mean Number of Pieces of Wood Burned Per Day	13.0	5.5	5.5
Total Number of Pieces of Wood Burned Per Week	2062.2	2116.4	69.3
Total Number of Pieces of Wood Burned in Winter Months	26808.0	27513.2	900.9
Total Cords of Wood Utilized in Winter Months	146.2	150.1	4.9

Table 4.1-5 Parameters used on PM_{10} emission calculation

Average Wood Density	23.9	pounds/cubic feet
Conversion factor	128	cubic feet/cord
Conversion factor	2000	pounds/ton
PM_{10} emission factor for residential wood fireplaces	34.6	pounds/ton
PM_{10} emission factor for residential wood stove	30.6	pounds/ton
PM_{10} emission factor for residential pellet stove	4.2	pounds/ton

Based on the survey data and parameters listed in the previous section, the PM_{10} emissions of the wood burning devices are calculated and summarized in Table 4.1-6. The total amount of PM_{10} emitted from the wood burning devices in Bernalillo County is estimate to be about 3,907 tons/year.

Table 4.1-6 PM_{10} emissions from residential wood burning devices in Bernalillo county

Wood Burning Stove		
Scale up the survey to reflect the number of wood burning stoves in the county	18,969	
The amount of wood burned in the winter	58,045.45	tons
Annual wood usage	116,090.89	tons
PM10 emissions	1,776.19	tons/year
Wood Burning Fireplace		
Scale up the survey to reflect the number of first wood burning fireplace in the county	96,015	
Scale up the survey to reflect the number of second wood burning fireplace in the county	7,785.00	
The amount of wood burned in the winter	61,523.10	tons
Annual wood usage	123,046.21	tons
PM10 emissions	2,128.70	tons/year
Pellet Stove		
Scale up the survey to reflect the number of pellet stoves in the county	5190	
The amount of pellet burned in the winter	519.00	tons
Annual pellet usage	1,038.00	tons
PM10 emissions	2.18	tons/year
Total	3,907	tons/year

4.2 Structure, Vehicle and Ordinance Fires

A database of structure and vehicle fires was obtained from the Albuquerque Fire Department for fire that occurred during 2004 (Holcomb, 2006). A listing of ordinance and explosive device events was extracted from the COA open burn database for the year 2005 (Summers, 2005). Table 4.2-1 shows the PM_{10} emissions from open burn/open detonation in the city of Albuquerque during 2005. The emission factors are based on the values used in the USEPA Open Burn/Open Detonation Dispersion Model (OBODM) (Bjorklund et al., 1998). Due to the fact that detailed information are missing or emission factors have not been established for some of the fuels/explosives burned, emission factors of fuels/explosives as shown in the "Notes" column of the table are used to describe some of the assumptions. Overall, about 73 tons of PM_{10} have been emitted from open burn/open detonation in the city of Albuquerque in 2005.

Table 4.2-1. PM_{10} emissions from open burn/open detonation

Material	Qty	Units	Emission Factor	Units	PM10 Emissions	Units	Notes
ANFO	44,700	lbs.	0	lbs./lbs	0	lbs.	
C-4	1710	lbs.	0.452	lbs./lbs	772.92	lbs.	RDX
dynamite	200000	lbs.	0.596	lbs./lbs	119200	lbs.	Fuze, Bomb, Tail, FMU 139A/B
Explosives	18515	lbs.	0.0926	lbs./lbs	1714.489	lbs.	TNT
Gas	3,005	Gallons	1.01591E-06	lbs/gallon	0.0030528	lbs.	
H6	995	lbs.	0.369	lbs./lbs	367.155	lbs.	
High explosive	32825	lbs.	0.181	lbs./lbs	5941.325	lbs.	HBX
Hydrogen Peroxide	45	lbs.	0	lbs./lbs	0	lbs.	
JP-8 fuel	5700	Gallons	0.195	lbs./lbs	1111.5	lbs.	from AQUIS
lg. grain gun powder/propellant	1300	lbs.	0.91	lbs./lbs	1183	lbs.	Propellant, M31A1E1
Liquid Natural Gas	400	Gallons	0.0006	lbs./gallon	0.24	lbs.	
Propane	300	Gallons	0.0006	lbs./gallon	0.18	lbs.	
propellants	100	lbs	0.00877	lbs./lbs	0.877	lbs.	Propellant, M-3 (ambient conditions)
Rocket Motor Fuel	12570	lbs	0.431	lbs./lbs	5417.67	lbs.	Propellant, ammonium perchlorate,Al
Small Arms	2000	lbs.	0.91	lbs./lbs	1820	lbs.	Propellant, M31A1E1
Thermite	350	lbs.	0.431	lbs./lbs	150.85	lbs.	Propellant, ammonium perchlorate,Al
Waste Explosive	3800	lbs.	1.91	lbs./lbs	7258	lbs.	Manufacturer's Waste (65% propell.)
WAY Propellant	1000	lbs.	0.91	lbs./lbs	910	lbs.	Propellant, M31A1E1
Wood	500	lbs.	0.015	lbs./lbs	7.5	lbs.	
Diesel	10	lbs.	0.00544	lbs./lbs	0.0544	lbs.	
SUM					145856	lbs.	
					73	tons	

Table 4.2-2 shows the PM_{10} emissions from house and vehicle fires in the city of Albuquerque in 2005. The emission factors are acquired from EPA AP-42 and listed in the table. The assumptions made in the calculations are listed in the last column of the table. No detailed information is available for certain fire categories. Emissions have not been estimated for these fires. Emissions from biomass burning (e.g. forest, grass, vegetation, etc.) are calculated separately and not listed in this table. A total of ~2.4 tons of PM_{10} are emitted from house and vehicle fires in the city of Albuquerque in 2005.

Table 4.2-2. PM_{10} emissions from house and vehicle fires

Type	Incident Count	Emission Factor	Unit	Emissions	Unit	Notes
Fire, other	77	N/A	lb/fire	N/A	lb	N/A
Building fire	275	12.42	lb/fire	3415.5	lb	based on 1.15 ton/fire
Fires in structures other than in a building	21	12.42	lb/fire	260.82	lb	based on 1.15 ton/fire
Cooking fire, confined to container	129	0.05	lb/fire	6.45	lb	Negligible
Chimney or flue fire, confined to chimney or flue	16	0.1	lb/fire	1.6	lb	Negligible
Incinerator overload or malfunction, fire confined	2	0.1	lb/fire	0.2	lb	Negligible
Fuel burner/boiler malfunction, fire confined	5	0.1	lb/fire	0.5	lb	Negligible
Commercial Compactor fire, confined to rubbish	6	0.4	lb/fire	2.4	lb	based on 50 lbs/fire
Trash or rubbish fire, contained	501	0.16	lb/fire	80.16	lb	based on 20 lbs/fire
Fire in mobile home used as fixed residence	5	12.42	lb/fire	62.1	lb	based on 1.15 ton/fire
Fire in motor home, camper, recreational vehicle	6	12.42	lb/fire	74.52	lb	based on 1.15 ton/fire
Fire in portable building, fixed location	3	12.42	lb/fire	37.26	lb	based on 1.15 ton/fire
Mobile property (vehicle) fire, other	28	2	lb/fire	56	lb	based on 1 car/fire
Passenger vehicle fire	373	2	lb/fire	746	lb	based on 1 car/fire
Road freight or transport vehicle fire	25	2	lb/fire	50	lb	based on 1 car/fire
Water vehicle fire	2	2	lb/fire	4	lb	based on 1 car/fire
Self-propelled motor home or recreational vehicle	1	2	lb/fire	2	lb	based on 1 car/fire
Outside rubbish fire, other	46	0.16	lb/fire	7.36	lb	based on 20 lbs/fire
Outside rubbish, trash or waste fire	152	0.16	lb/fire	24.32	lb	based on 20 lbs/fire
Construction or demolition landfill fire	1	12.42	lb/fire	12.42	lb	based on 1.15 ton/fire
Dumpster or other outside trash receptacle fire	32	0.16	lb/fire	5.12	lb	based on 20 lbs/fire
Special outside fire, other	11	N/A	lb/fire	N/A	lb	N/A
Outside storage fire	5	0.16	lb/fire	0.8	lb	based on 20 lbs/fire
Outside equipment fire	10	N/A	lb/fire	N/A	lb	N/A
Outside gas or vapor combustion explosion	3	1.01591E-05	lb/fire	3.04772E-05	lb	based on 10 gallon/fire
TOTAL	1,735			4,850	lb	
				2.42	Ton	

4.3 Charbroiling

Per capita consumption of major food commodities are obtained from U.S Census Bureau, Statistical Abstract of the United States, 2006. Total consumption is estimated as the product of per capita consumption, estimated population of Bernalillo County and a factor 0.4 to account for food away from home. Data for at-home and away-from-home are obtained from Average annual expenditures of all consumer units are obtained from U.S. Census Bureau, 2006. Emission factors were obtained from California Energy Commission, Energy-related Environment Research, Commerical Kitchen Ventilation and Emissions, 12/1999.

Table 4.3-1. PM_{10} emissions from Charbroiling

Type	Per Capita consumption (lbs / yr)	Total consumption (tons)	EF (tons PM_{10} / tons of food)	PM_{10} emissions (tons PM_{10} / Yr)
Beef	62	6,678	32.7	218
Veal	0.5	54	17.2	1
lamb	0.8	86	17.2	1
Pork	48.5	5,224	32.7	171
Chicken	57.5	6,193	10.5	65
Turkey	13.8	1,486	10.5	16
Fish	16.3	1,756	3.3	6
Total		**21,477**		**478**

4.4 Agriculture

According to the 2004 New Mexico Agricultural Statistical summary, there were a total of 618 farms operational during 2004 and practically produced only hay. Bernalillo county ranks 18th in terms of hay production in the state of New Mexico. Figure 4.4-1 shows the locations of the farming areas based on the National Land Cover Database GIS data (NLCD, 2001).

As the map in Figure 4.4-1 illustrates, virtually all of the agricultural land is pasture in Bernalillo County, indicated by the green areas on both sides of the Rio Grande River. A high density of hay producing area lies within Isleta tribal land in the extreme south end of the county below I-25. Other agricultural activities in the county include animal husbandry to include 11,000 head of cattle and calves, 3,000 head of milk cows in addition to 1,600 head of sheep and lambs.

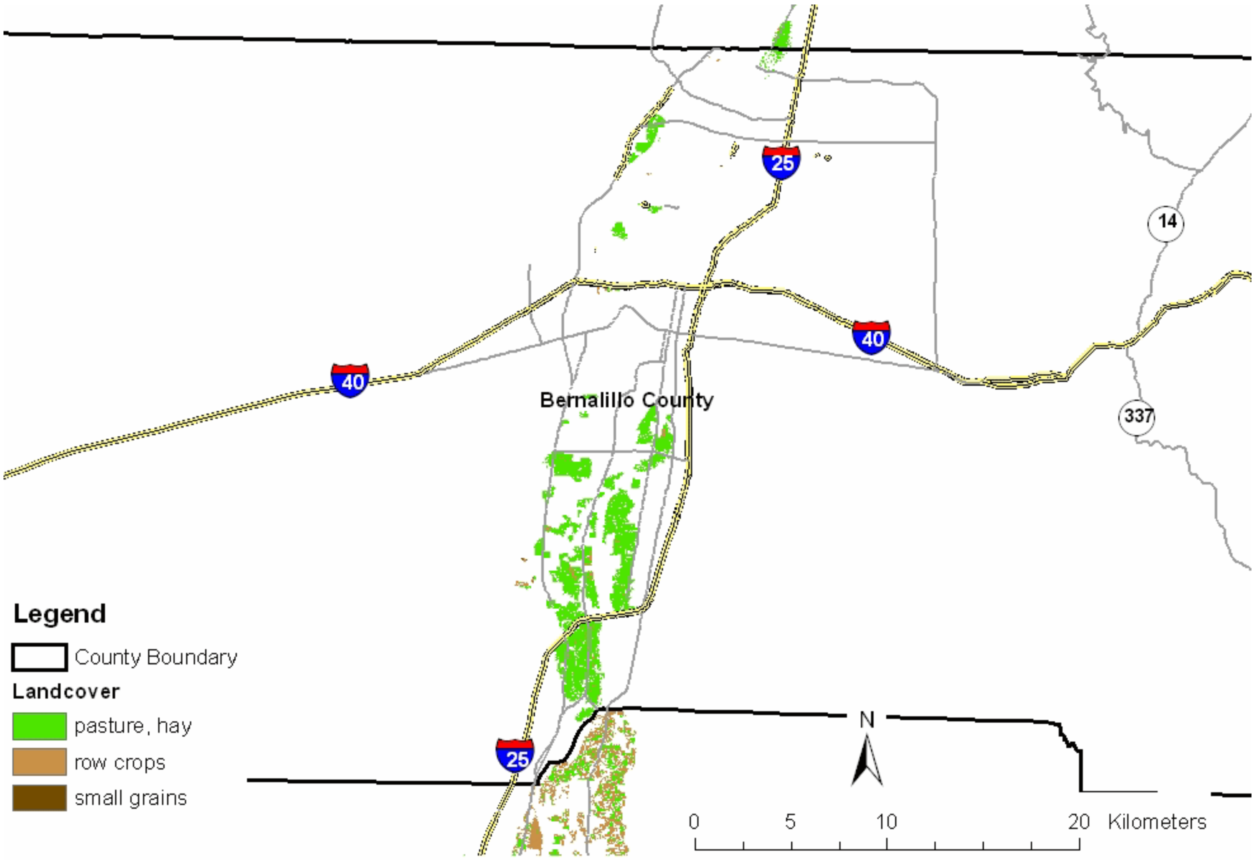


Figure 4.4-1 Agricultural lands in Bernalillo County

4.4.1 Land Preparation

Since alfalfa is a long-lived perennial, these fields do not require annual tilling and growers typically disc and seed alfalfa maybe only once every 3 or 4 years. During a typical year alfalfa is harvested from May to mid-October.

Emission factors for tilling, seeding, and harvesting of other crops are currently not included in AP-42 despite their importance to overall PM emissions on a national scale. Calculation of alfalfa land preparation will follow the methodology published by the California Air Resources Board for use in PM_{10} State Implementation Plans for the San Joaquin Valley (CARB, 2003). PM_{10} emissions from land preparation are based on studies conducted by UC Davis for use in SIP preparation. Annual emissions are calculated based on the following equation:

$$\text{Emissions} = Area \times Emission\,Factor \times AcrePasses$$

where:

Emission Factor = constant 2.76 lbs of PM_{10}/acre-pass
Area = acres of alfalfa
AcrePasses = number of passes in a year for land preparation

Operations included in this emission calculation are discing, shaping, chiseling, leveling, and other mechanical operations used to prepare the soil. PM_{10} emissions are produced by the mechanical disturbance of the soil by the implement used and the tractor pulling it. The emission factor does not consider properties of the soil (i.e. vegetative cover and soil moisture) that are likely to influence the total emissions from tilling.

Alfalfa fields are typically harvested between four to five times per season in Bernalillo County based on data collected by the NMSU Extension office in Bernalillo County. The number of passes per year was compared to the 2004 National Crop Residue Management Survey Data (Conservation Technology Information Center). According to the 2004 New Mexico Agricultural Statistical summary, there were a total of 4,900 acres of hay harvested (3,400 acres from alfalfa hay and 1,500 from other hay). On an annual basis, not all 4,900 acres are tilled. When the alfalfa plant density falls below certain number, the field is usually replanted. Common practice by alfalfa growers is to till and reseed the fields every 3 to 4 years. The farmer may also dictate a crop rotation at this frequency. An assumption was made to estimate the number of acres tilled county-wide in one year by dividing the total number of acres by 3. Emissions from tractors during harvesting are included in the section 3.7, Estimation of Non-Road Mobile Sources.

Table 4.4-1. PM_{10} emissions from alfalfa and hay land preparation

Type	Emission Factor (lbs/acre-pass)	SJV (acres)	SJV (acre-passes)	Number of passes/year	Acres	PM_{10} emissions (tons)
Alfalfa	2.76	515,095	746,888	1.45	1,133	2.27
Other hay	2.76	38,357	55,618	1.45	500	1.00
Total						**3.27**

4.4.2 Harvesting

Calculation of alfalfa and hay harvesting will follow the methodology published by the California Air Resources Board for use in PM_{10} State Implementation Plans for the San Joaquin Valley (CARB, 2003). During a typical year alfalfa is harvested from May to mid-October. Annual emissions are calculated based on the following equation:

$$\text{Emissions} = Area \times Emission\,Factor$$

Table 4.4-2. PM_{10} emissions from alfalfa and hay harvesting

Type	Emission Factor (lbs/acre)	Area (acres)	PM_{10} emissions (tons)
Alfalfa	1.69	1,133	0.96
Other hay	1.69	500	0.42
Total			**1.38**

Based on this emission methodology, alfalfa and hay land preparation and harvesting emits an estimated 4.7 tons per year of PM_{10}.

4.4.3 Agricultural Unpaved Roads

This source type includes fugitive emissions from unpaved roads located on agricultural land and due to vehicle activity such as pick-up trucks and some larger vehicles used for harvesting and tilling.

Table 4.4-3. PM_{10} emissions from agricultural unpaved roads

Crop	Acreage	VMT/acre/year	Total VMT/year	PM_{10} (tons/year)
Hay (Alfalfa)	3,400	4.375	14,875	16.9
Hay (Other)	1,500	4.375	6,563	7.4
Total			**21,438**	**24.3**

4.5 Construction Fugitive Dust

Construction activity was obtained from the COA Air Quality Division's programmatic and construction permit program databases from 2004. The programmatic permits are for long-term construction projects that may take years to complete. The programmatic database contained information on the owner, address, project start date, active acres and location UTM or latitude/longitude. There is no way of determining the duration of emissions from these sources since these permits are valid for a period of five years. The majority of dust control permits issued are construction permits and are for short-term projects less than six months. The Air Quality Division construction dust control permits are valid for one year although the projects are probably started and completed with a month or so after the permit is issued. The construction permit database contained information on the owner, address, project start date, and active acres.

Construction emissions are from active operations to include blading, earthmoving, and grading.

$$\text{Emissions} = Area \times Emission\,Factor$$

Area was determined from COA dust regulation registration database for 2004. Emission factors were obtained from the WRAP Dust Handbook and are based on the 1996 BACM study conducted by Midwest Research Institute for the California South Coast Air Quality Management District (WRAP, 2004; MRI, 1996). Emission factors were measured for construction sites in the Coachella Valley, South Coast, San Joaquin Valley in California as well as in Las Vegas, Nevada.

For this inventory, we use emission factors when only disturbed area and duration are known. Light construction assumes an emission factor of 0.11 tons PM_{10}/acre-month and represents average conditions. The 1996 MRI report includes an emission factor for worst-case emissions of 0.42 tons PM_{10}/acre-month to represent heavy construction. This emission factor is appropriate for large-scale construction operations, which involve substantial earthmoving operations. This can include operations such as the construction of a building or a road. The

South Coast Air Quality Management District estimated that 25% of their construction projects involve these types of operations. A ratio of 3/1 was also used for light/heavy construction activities in Bernalillo County

Table 4-5.1 Summary of construction fugitive dust emissions

Type	EF (ton/acre/year)	Acres	PM_{10} emissions (tons/year)
Light Construction	1.32	2,284	3,015
Heavy Construction	5.04	761	3,837
Total		**3,045**	**6,851**

4.6 Paved Road Dust

This source type includes emissions due to resuspended road dust from all county and city paved roads. Vehicle shape, speed, weight, number of wheels as well as previous history (e.g. dust acquisition for trackout) interact with different road surfaces to change the particle size, surface loading, wind effects, and surface moisture. Vehicular traffic adds to particle suspension because tire contact creates a shearing force with the road that lifts particles into the air. Moving vehicles also create turbulent wakes that act much like natural winds to raise particles. Dust on paved roads is continually replenished by action from vehicular turbulence and rain. Minimizing the deposition of fresh dust onto these surfaces is a viable method for reducing their PM emissions. Dust loadings on a paved road surface build up by being tracked out from unpaved areas such as construction sites, unpaved roads, parking lots and shoulders; by spills from trucks carrying dirt and other particulate materials; by transport of dirt collected on vehicle undercarriages; by wear of the pavement surface; by deposition of suspended particles from many emission sources; and by water and wind erosion from adjacent areas.

A field program to study the effects of unpaved shoulders along a paved road concluded that large traffic-induced turbulence events that led to significant dust entrainment were almost exclusively caused by "large" vehicles such as trucks, semis, and vehicles pulling trailers, all traveling 50–65 mph (Moosmuller et al., 1998). PM_{10} emission rates for these large, fast-traveling vehicles were determined to be 8 ± 4 grams per vehicle kilometer traveled under dry conditions. Emissions due to smaller vehicles such as cars, vans, and sport utility vehicles were negligible for normal on-road driving. These results indicate that the majority of PM_{10} emissions from unpaved shoulders is caused by relatively few vehicles.

The emissions estimated in this section are only estimated particulate emissions from resuspended road surface material. The particulate emissions from vehicle exhaust, brake wear and tire wear are estimated separately using EPA's MOBILE 6.2 and summarized in section 3. According to AP-42 for paved public roads, the emission factor for PM_{10} in pounds of PM_{10} per vehicle miles traveled (VMT) is

$$\mathrm{EF} = \left[k \left(\frac{sL}{2} \right)^{0.65} \left(\frac{\mathrm{W}}{3} \right)^{1.5} - C \right] \left(1 - \frac{P}{4N} \right)$$

where EF is the emission factor in pounds per VMT, k is the particle size constant in pounds per VMT, sL is the silt loading in grams per square meter, W is the mean vehicle weight in tons, C is the emission factor for 1980's vehicle fleet exhaust, P is the number of days in a year with at least 0.254 cm (0.01 inch) of precipitation and N is the number of days in the averaging period. Table 4.6-1 summarizes the values used in the AP-42 equation for this inventory.

Table 4.6-1 Constants used in the paved road emission factor

Constant	Description	Value
k	particle size specific constant	0.016 lb/VMT
sL	Silt loading	in g/m^2; depends on daily traffic volume
W	Average vehicle weight	3 tons
C	Age correction factor	0.00047 lb/VMT
P	# of days/year with 0.01" rain	49
N	Number of days in averaging period	365 days

PM_{10} emissions from paved road dust are calculated by multiplying emission factor by the vehicle miles traveled (VMT) for each type of paved road to obtain emissions per road type.

Table 4.6-2 Summary of annual paved road emissions

Class	Road Type	Daily VMT	Annual VMT	sL (g/m^2)	PM_{10} EF (lbs/VMT)	PM_{10} Emissions (tons/year)
Urban	Interstate	4,146,250	1,513,381,250	0.015	0.0001886	142.7
Urban	Other Principal Arterial	5,113,890	1,866,569,850	0.030	0.0005545	517.5
Urban	Other Major Arterial	1,720,143	627,852,195	0.030	0.0005545	174.1
Urban	Collector	1,302,485	475,407,025	0.060	0.0011286	268.3
Urban	Local	1,389,900	507,313,500	0.200	0.0030075	762.9
Rural	Interstate	633,787	231,332,255	0.015	0.0001886	21.8
Rural	Minor Collector	74,522	27,200,530	0.200	0.0030075	40.9
Rural	Major Collector	157,448	57,468,520	0.060	0.0011286	32.4
Rural	Local	259,530	94,728,450	0.600	0.0066158	313.4
Total		14,797,955	5,401,253,575			**2,273.9**

4.7 Unpaved Road Dust

This source type includes all county and city roads that are gravel or dirt in the county. Figure 4.7-1 shows the locations of all unpaved roads in the county according to the public works department GIS.

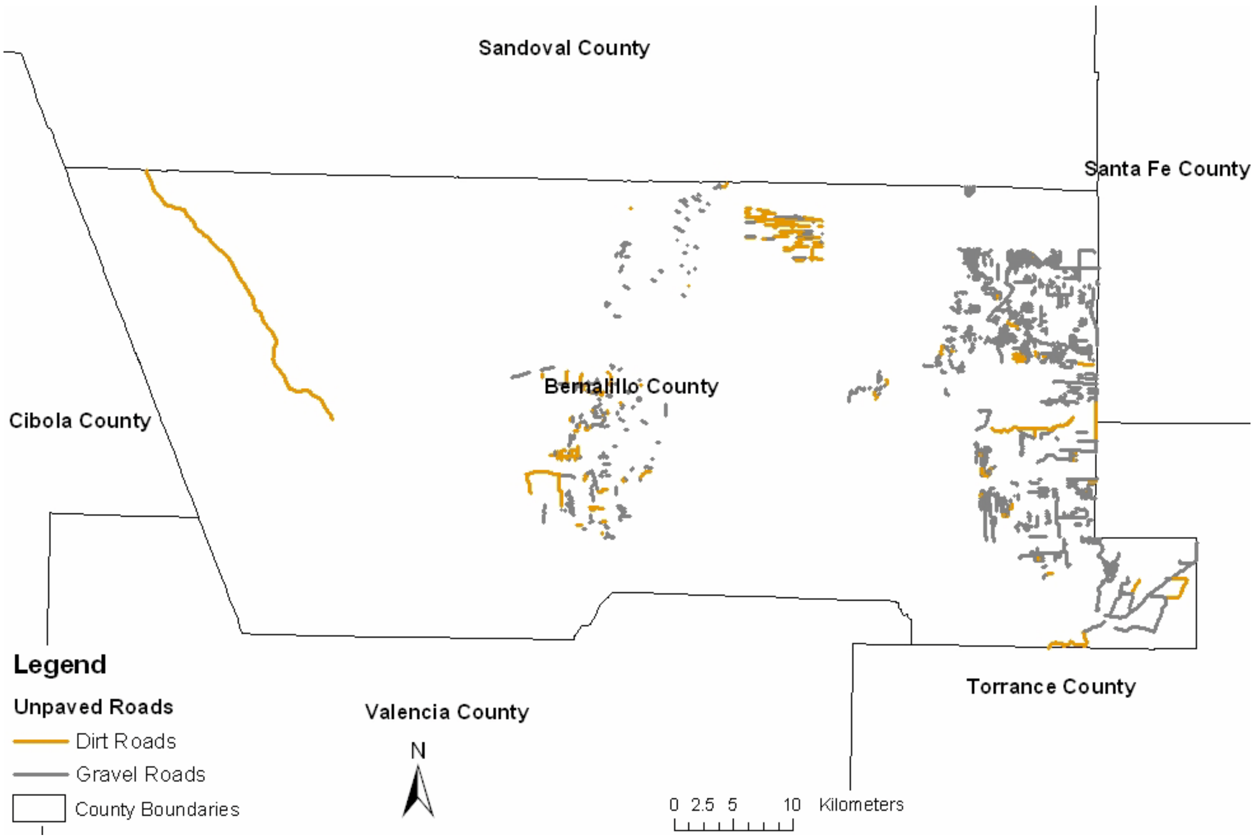


Figure 4.7-1 Unpaved roads in Bernalillo County based on GIS data from Bernalillo County Public Works Department

According to AP-42 for unpaved public roads, the emission factor for PM_{10} in pounds of PM_{10} per vehicle miles traveled (VMT) is

$$\mathrm{E} = \left(\frac{k(s/12)^{a}(S/30)^{d}}{(M/0.5)^{c}} - C \right) \left(\frac{365 - \mathrm{P}}{365} \right)$$

where s is the surface material silt content in percent, S is the mean vehicle speed in miles per hour, M is the surface material moisture content in percent, P is the number of days in a year with at least 0.254 cm (0.01 inch) of precipitation and C is the emission factor for 1980’s vehicle fleet exhaust, brake and tire wear. Table 4.7-1 summarizes the values used in the AP-42 equation for this inventory.

A 7 percent silt content was chosen based on measurements taken during a field study at Ft. Bliss to measure unpaved road emissions (Kuhns et al., 2005). Percent moisture data are retrieved from Sevilleta, Long-Term Ecological Reserve data (Moore, 2001).

Table 4.7-1 Constants used in the unpaved road emission factor

Constant	Description	Value
k	particle size specific constant	1.8 lb/VMT
s	Silt content	7%
a	Silt content exponent	1
S	Mean vehicle speed	35 mph
d	Vehicle speed exponent	0.5
M	Surface moisture content	8%
c	Moisture content exponent	0.2
P	# of days/year with 0.01" rain	49
C	Age correction factor	0.00047 lb/VMT

Hourly soil moisture from Sevilleta sites 40 and 42 was averaged over one year to arrive at a mean moisture content. A mean vehicle speed of 35 mph was used based on knowledge of local roads in Bernalillo County although a speed of 50 mph is recommended from the WRAP Dust Handbook (WRAP, 2004). The number of days with precipitation for 2004 was obtained from data collected at the Albuquerque International Airport.

Silt content is an indicator of the amount of particles less than 75 μm in the soil sample. A recent analysis of soil samples collected across California indicated that dry silt content is not a reliable surrogate for PM_{10} emission potential since a soil sample may have a large silt content, but a small PM_{10} content (Carvacho et al. 2001). Silt content for use in AP-42 is determined by sieving dried soil samples acquired from surface loading tests. Silt content is measured using a 200 mesh screen as defined by the ASTM method C-136. Soil scientists commonly speak of the term "silt" which does not refer to the same quantity as "silt content" as used in AP-42. Soil scientists use the term "silt" as particles with sizes between 2 and 50 μm. They also call sand as particles from 50 to 2000 μm and clay as the smallest particles less than 2 μm. These particle fractions are measured by a combination of wet sieving and pipetting using ASTM method 136-95a. One way to estimate the AP-42 "silt content" is to sum silt and clay. The percent silt and clay content was obtained from CONUS-Soil soil fraction database (Miller and White, 1998). This value compares with a previous study of soil properties in the San Joaquin Valley of California where silt content varied from 11 to 94 percent (Ashbaugh et al., 2003).

Unpaved road VMT was calculated using a common practice of multiplying the total number of miles of unpaved roads by the average daily traffic volume (ADTV). Thus, the emissions in tons per year are calculated by multiplying the ADTV, the miles of unpaved roads, the unpaved road emission factor, the number of pounds in a ton and the number of days in a year. Since unpaved road ADTV is not measured, an estimate based on a method used by WRAP will be used. ADTV is based on a study conducted in Clark County, Nevada for their 2001 PM_{10} SIP to estimate urban unpaved road volume. In that survey, an average ADTV or 69.2 was obtained. For this inventory, the Clark County ADTV was adjusted for population density. An estimation of the ADTV in Bernalillo County can then be expressed as the following equation,

$$\mathrm{ADTV}_{\mathrm{Bernalillo\,County}} = ADTV_{Clark\ County}\left(\frac{Bernalillo\ County\ Population\ Density}{Clark\ County\ Population\ Density}\right)$$

Assuming data from 2003 summarized in Table 4-8.2, a population adjusted ADTV is obtained.

An adjusted unpaved road ADTV for Bernalillo County is then calculated to be 34.1 vehicles per day. Using that ADTV to calculate total PM_{10} emissions, results in 1,292 tons per year for all unpaved roads in the county.

Table 4.7-2 Constants used in the calculation of ADTV for Bernalillo County

Description	Value
Area of Clark County nonattainment area for PM_{10} (hydrographic area 212)	1,564 square miles
Total area of Bernalillo County	1,166 square miles
Population of of nonattainment area within Clark County in 2003	1,583,172
Population of Bernalillo County in 2003	582,461

4.8 Exempt Fugitive Dust Sources

According to NMAC 20.11.20.2 Section C, eight source types are exempt for three years from the effective date of the regulation. An attempt to estimate annual PM_{10} emissions from each exempt source type is presented in this section.

4.8.1 Agricultural Areas

See section 4.6 on agricultural land preparation and harvesting.

4.8.2 Recreational Trails

This category include bicycle trails, hiking paths, pedestrian paths, horse trails or similar paths used exclusively for purposes other than travel by motor vehicles.

According to the City of Albuquerque Geographic Information System Division, there are 239 miles of urban bicycle trails, lanes and routes within the city. From this source of information, all of the paved trails are located within the urbanized portion of the valley. Of those 230 miles, 79 miles (127 km) are dedicated bicycle trails closed to automobile traffic. Figure 4.8-1 shows the locations of these recreational trails within the City of Albuquerque. The urban pedestrian and bicycle trails are 8 feet wide paved paths that follow drainage systems or arroyos and connect recreational areas as well as schools.

GIS data from the US Forest Service and the City of Albuquerque were obtained to locate and estimate the length of unpaved trails in the county. There are 163 miles (263 km) of unpaved trails within Bernalillo County as shown in Figure 4.8-2. From these sources of data all of the trails are located near on in the Sandia Mountains and primarily within Forest Service boundaries. The vast majority of these trails are for pedestrian use only with widths typically around 3 feet. A total of 156 miles (251 km) of these trails exist in the county based on Forest Service GIS data. Some trails are used for horseback riding as well as all-terrain vehicles and are called “2-track” having two paths merged into one wide trail. Based on a discussion with Sandia District rangers, we have identified at least 7.6 miles (12.2 km) of trails with a width of at least 6 feet.

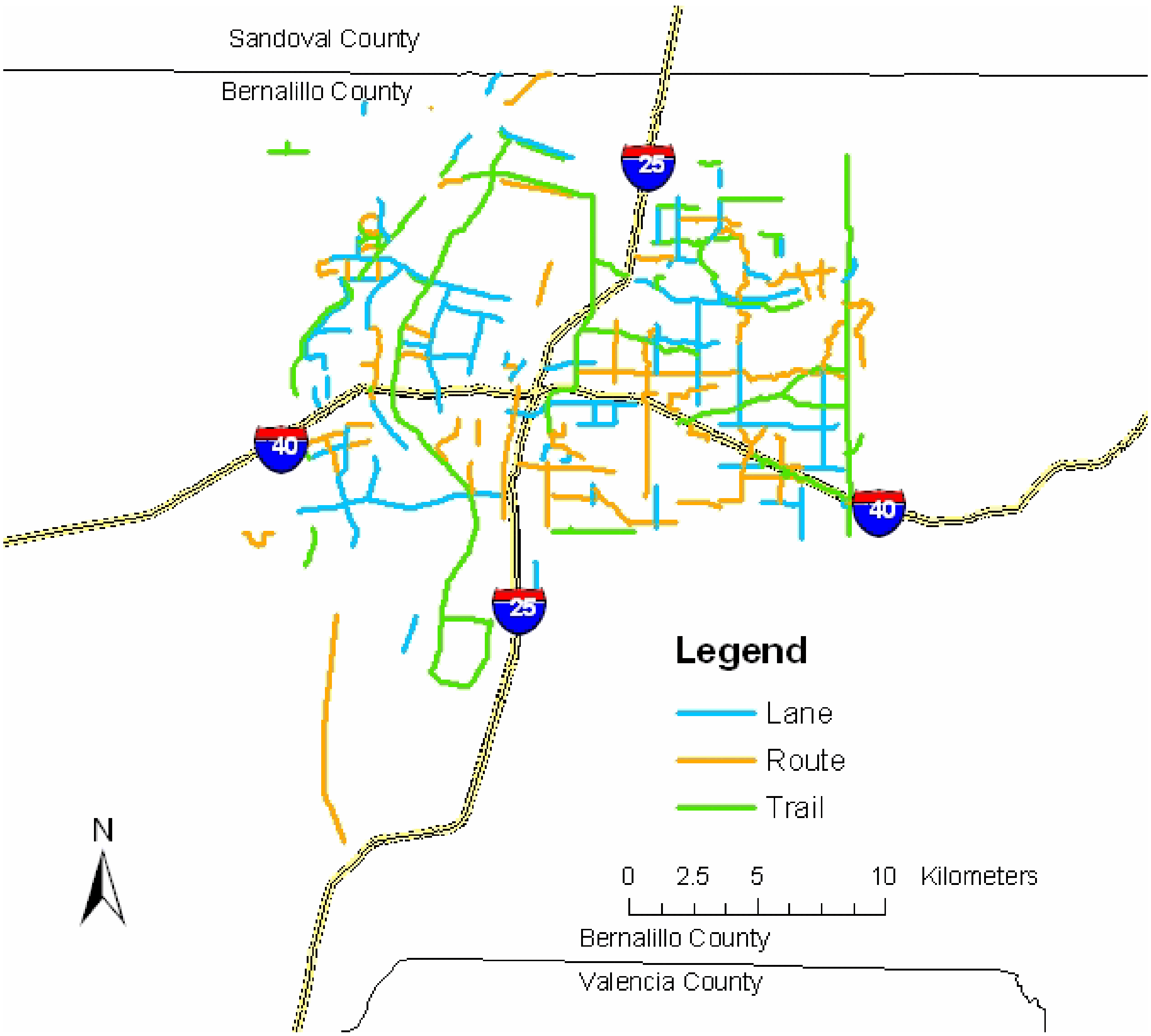


Figure 4.8-1 Locations of urban bike trails, routes and lanes in Bernalillo County

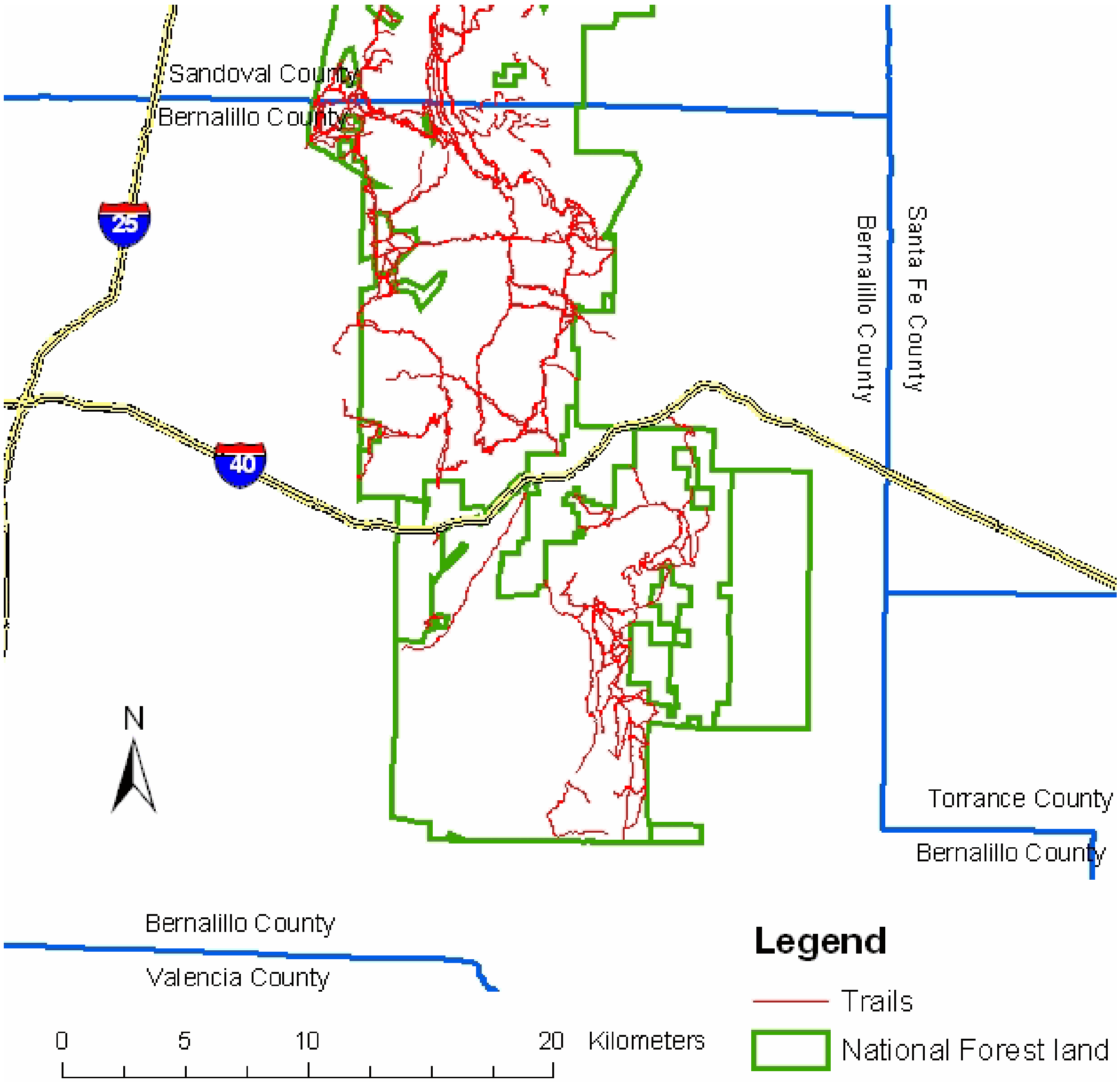


Figure 4.8-2 Locations of unpaved trails within Bernalillo County

For this inventory we will assume that emissions will come from wind generated dust. While there may be some quantifiable emissions from trail use from people walking, horses and ATVs, emissions from this activity is expected to be very small in comparison to the wind generated dust. The methodology used in this section follows that of section 4.9 for wind erosion from all open land in the county. Table 4.8-1 shows the values used in the calculation of wind generated dust from trails.

Table 4.8-1 Constants used in the calculation of windblown dust from paved and unpaved trails

Parameter	Unpaved walking paths (3 ft width)	Unpaved horse/ATV paths (6 ft width)	Paved walking paths (8 ft width)
Area (acres)	62	6	83
A	0.0125	0.0125	0.0125
I (ton/acre)	56	89	21
C	120	120	120
K	1	1	1
L (ft)	20	1,000	100
V (lb/acre)	-	-	-
Emission factor (lb/acre/yr)	233.7	233.7	56.7
Total Emissions	7.2	0.7	2.4

For all trails identified in the inventory, the total PM_{10} emissions is calculated to be 10.3 tons per year.

4.8.3 Residential Unpaved Roads

This category is for unpaved roadways serving six residential dwellings or fewer. Assuming an ADTV of 48 vehicles per day (VMT of 12 veh-mi/day) for each road at 0.25 miles of unpaved road, we estimate an emission of 1.05 tons per year.

Table 4.8-2 Calculation of Unpaved PM_{10} emission factor on residential roads

k (lb/VMT	Silt content (%)	Moisture content (%)	Mean vehicle speed (mph)	Number of days with precip	Emission Factor (lb/VMT)	Controlled emission factor (lb/VMT)
1.8	7	8	25	49	0.550	0.476

Based on GIS data from the City of Albuquerque and site visits, these areas could typically be found in the neighborhoods on the northeast north of Paseo del Norte, agricultural areas in the south valley, and in the east mountains area south of I-40.

4.8.4 Short Unpaved Roads

Unpaved roadways less than one-quarter mile in length that are not short-cuts. Assuming an ADTV of 34.1 vehicles per day (from section 4.7) for one road at 0.25 miles in length, we estimate an emission of 0.74 tons per year for that one length of unpaved road. Table 4.8-3 shows the values in the calculation of the emission factor for this source type.

Table 4.8-3 Calculation of Unpaved PM_{10} emission factor on short roads

k (lb/VMT	Silt content (%)	Moisture content (%)	Mean vehicle speed (mph)	Number of days with precip	Emission Factor (lb/VMT)	Controlled emission factor (lb/VMT)
1.8	7	8	25	49	0.550	0.476

4.8.5 Private Easement Unpaved Roads

This category represents unpaved roadways on private easements serving residential uses that are in existence at the time NMAC 20.11.20.2 Section C becomes effective. Assuming an ADTV of 4 vehicles per day (VMT of 0.4 veh-mi/day) for each road at 0.1 miles of unpaved road, we estimate an emission of 0.03 tons per year.

Table 4.8-4 Calculation of Unpaved PM_{10} emission factor on each private easement

k (lb/VMT	Silt content (%)	Moisture content (%)	Mean vehicle speed (mph)	Number of days with precip	Emission Factor (lb/VMT)	Controlled emission factor (lb/VMT)
1.8	7	8	25	49	0.550	0.476

Based on GIS data from the City of Albuquerque and site visits, these areas could typically be found in the neighborhoods on the northeast north of Paseo del Norte, agricultural areas in the south valley, and in the east mountains area south of I-40.

4.8.6 Forest Service Unpaved Roads

This category includes unpaved roadways on United States Department of Agriculture Forest Service or United States Department of Interior Park Service lands if the roadways are more than one-quarter of a mile from an occupied residence. Information on the locations and activity of these roads were collected from the Sandia Ranger District (Gormally, 2006), a field guide (Maurer, 1994), maps of the Sandia Ranger District (Ervin, 1997; USFS, 1993) and several site visits. Table 4.8-5 indicates some of the important unpaved roads within the Cibola National Forest.

Altogether the Forest Service boundary encompasses nearly 8,800 acres (13.75 mi^2) of land although it covers portions of private and Department of Defense land in the southern portion of the District.

The average daily traffic volume is needed to calculate the emissions on the unpaved roads. The approach used in this inventory required the number of people visiting the Sandia District land on an annual basis.

Table 4.8-5 Names and locations of important Forest Service unpaved roads

Name	Notes
FR462 (Chamisoso Rd)	High use from cars, trucks and ATVs
Hwy 165	High use from cars and trucks, unpaved from Forest Service boundary in the north to Capulin Springs (majority of road in Sandoval County)
FR252	Access from Juan Tomas, road to Cedro Peak Lookout tower, runs through private land
FR542	Access from Juan Tomas, road to Cedro Peak Lookout tower
FR242 (Juan Tomas Rd)	Runs through Forest Service and private land, high traffic, connects rural communities to Hwy 337
FR530	Going to be gated and closed to motorized vehicles from a 1996 decision
FR542	
FR413	South end of Sandia District-becomes Anaya Rd (paved at Anaya Rd)
FR321	2-track (2-path dirt road), seldom used, Follows David Canyon south of FR530
FR106	2-track road (2-path dirt road), seldom used

Based on data from the Cibola National Forest, Sandia District, they estimate approximately 2 million people travel on Forest Service land each year. Data to calculate the Average Daily Traffic Volume (ADTV) is summarized in Table 4.8-6. We make the assumption that most people travel on the paved roads and that 5 percent drive on unpaved roads. This is an estimate since actual statistics could not be found.

Table 4.8-6 Calculation of ADTV for Forest Service roads

Visitors (people/ yr)	People per vehicle	Number of Vehicles	Total Miles of Roads	Total ADTV (vehicles/ day)	Fraction of people on unpaved roads	Unpaved ADTV (vehicles/ day)
2,000,000	3	666,667	210	1,826	0.05	91

We use the AP-42 equation for estimating the unpaved roads emission factor in this inventory

$$E = \left(\frac{k(s/12)^a (S/30)^d}{(M/0.5)^c} - C \right) \left(\frac{365 - P}{365} \right)$$

where each constant is defined in Table 4.8-7.

Table 4.8-7 Calculation of Unpaved PM_{10} emission factor on Forest Service roads

k (lb/VMT	Silt content (%)	Moisture content (%)	Mean vehicle speed (mph)	Number of days with precip	Emission Factor (lb/VMT)	Controlled emission factor (lb/VMT)
1.8	7	10	25	49	0.526	0.455

Total unpaved road emissions are then calculated by multiplying the controlled emission factor by the number of miles of unpaved roads with the VMT. The controlled emission factor uses the number of days of at least 0.01 inches of precipitation in a year to limit the emissions. Using the number of miles of unpaved roads at 18 miles and a VMT or 4566 vehicle*miles/day, the total emissions is 133 tons per year.

4.8.7 Ranching and Federal Unpaved Roads

This includes unpaved roadways within properties used for ranching and unpaved roadways within properties owned or controlled by the United States Department of Energy or the Department of Defense. However, this exemption only applies if the public does not have motor vehicle access to the roadways. Based on the City of Albuquerque's Geographic Information System Division, the area of US Army controlled land is approximately 2,509 acres (10.2 km^2). This source type includes fugitive emissions from unpaved roads located on ranching areas and Kirtland Air Force Base land and due to vehicle activity such as pick-up trucks and some larger vehicles used for experimental research, security and maintenance. The emission factor for agricultural activity will be used for this source type since specific information on the traffic and number of roads used on DOD land is not available. For this calculation an emission factor of 2.27 pounds of PM_{10} per vehicle mile traveled will be used with an assumption of activity of 175 VMT per 40 acres of land per year.

Table 4.8-8. PM_{10} emissions from ranching and DOD unpaved roads

Crop	Acreage	VMT/acre/year	Total VMT/year	PM_{10} (tons/year)
DOD and ranching land	2,509	4.375	10,979	12.5

The total DOD and ranching PM_{10} annual emissions is calculated to be 12.5 tons per year.

4.8.8 Residential Lots

This source category includes lots occupied by dwellings used solely for residential purposes or solely for non-commercial livestock operations smaller than 0.75 acre, not including lots smaller than 0.75 acre used for other purposes. Our approach to emissions from residential lots is to estimate the amount of PM_{10} from wind erosion per neighborhood of 100 houses.

Assuming an individual lot size of 0.75 acre, a community of 100 lots will potentially emit as much as 8.8 tons per year of PM_{10} from wind erosion. For smaller lots of 0.1 acres, a community of 100 houses will emit approximately 1.2 tons per year.

Table 4.8-9 Calculation of PM_{10} emissions from residential lots

Variable	Units (in 100s)	Residential lot (0.75 acre)	Residential lot (0.1 acre)
Units (0.7 acre)	1	75	
Units (0.1 acre)	1		10
A	tons / acre	0	0
I		56	56
C		120	120
K		1	1
L	ft	20	20
V	lb / acre	-	-
Emission factor	lb / acre / yr	233.7	233.7
Emissions	tons / yr	8.8	1.2

4.9 Windblown Fugitive Dust

The following windblown dust PM_{10} source categories are inventoried:

- Agriculture
- Unpaved roads
- Open shrubland areas
- Forests

The Wind Erosion Equation (WEQ) erosion model is designed to predict long-term average annual soil losses from a field having specific characteristics (USDA, 2005). With appropriate selection of factor values, the equation will estimate average annual erosion.

The emission factor used for dust emissions estimations from wind erosion of the aforementioned dust source categories is based on an equation developed by the U.S. Department of Agriculture. The equation was originally derived in the 1960's to predict topsoil losses from agricultural fields. In 1974, the equation was modified by Midwest Research Institute (MRI) to estimate the quantity of the eroded soil that is entrained to the air. The PM_{10} emission factor (EF) equation is as follows:

$$EF = A \times I \times C \times K \times L \times V$$

where:

EF is the quantity of unpaved road dust entrained to the air by wind erosion (in tons of PM_{10} / acre / year);

A is portion of the total roadway wind erosion losses that are assumed to be suspended into the air;

I is the soil erodibility estimated by U.S. Department of Agriculture estimated from wind erosion group (in tons / acre);

C is the climatic factor (dimensionless);

K is the surface roughness factor (dimensionless);

L is the unsheltered field width factor (in ft);

V is the vegetative cover factor (lbs / acre).

4.9.1 Entrained Soil Factor (A)

This factor was derived by MRI, and it is the estimated quantity of the total eroded material that actually gets suspended to the air. The A values for particles with diameter less than 10 μm for different land types are presented in Table 4.9-1.

Table 4.9-1 Typical Entrained soil factor (A) values for different types of land

Source	Entrained PM_{10} Soil Factor
Unpaved roads	0.019
Agricultural, forest and open lands	0.025

4.9.2 Soil Erodibility (I)

The soil erodibility is related to the soil type of the surface. The county soil types are computed using a geographic information system (GIS) to average detailed county soil profile maps provided by the Natural Resources Conservation Service. Figure 4.9-1 shows the spatial variation of WEG in Bernalillo County, and Table 4.9-2 describes the soil properties for each WEG and I group.

To identify the land use and obtain the association between land use and soil erodibility, the National Land Cover Characterization 2001 (NLCD, 2001) database was obtained from the USGS. The database provides a 30 m by 30 m delineation of land use using 19 categories that are shown in Table 4.9-3 and Figure 4.10-2.

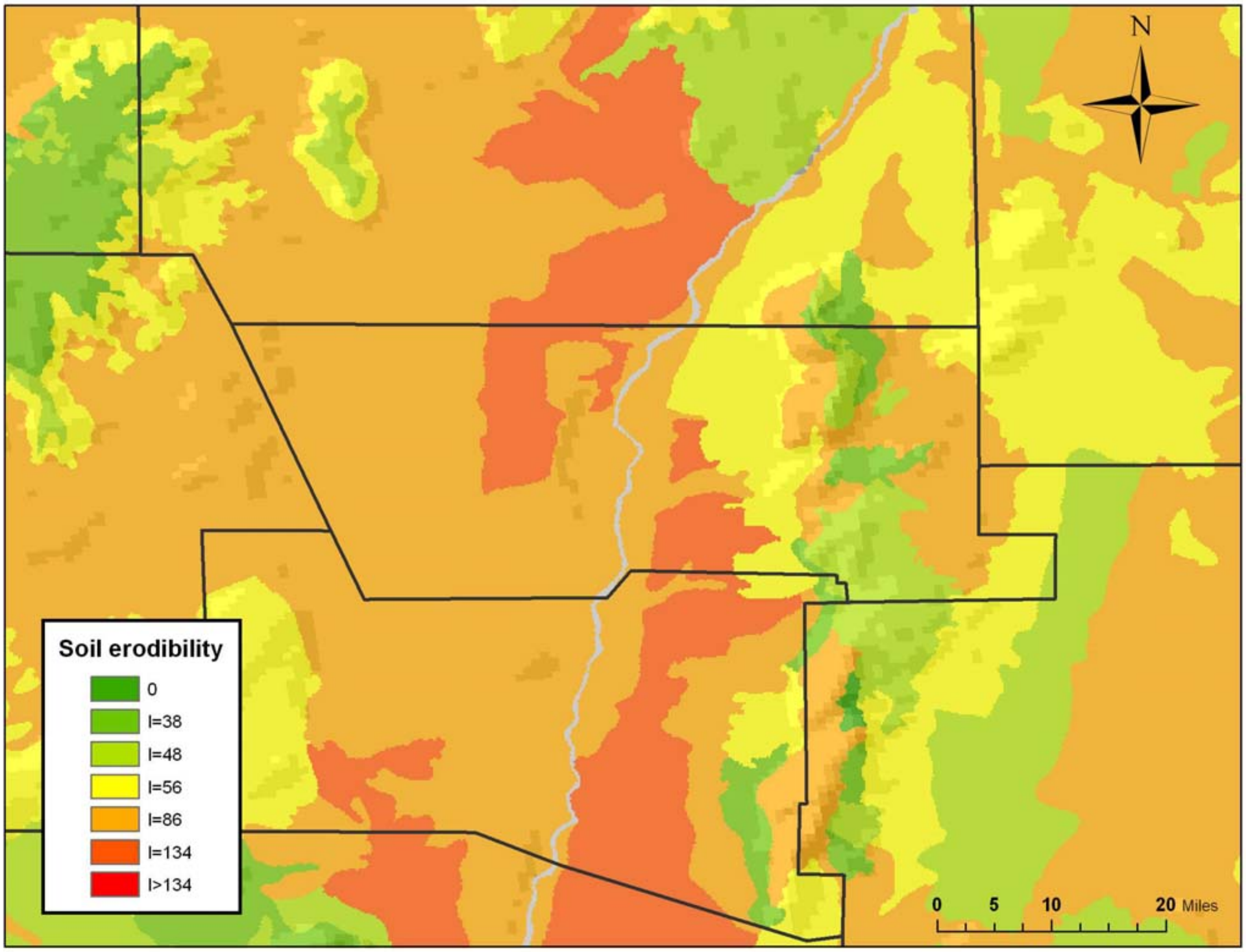


Figure 4.9-1 Soil erodibility for Bernalillo County and nearly surroundings

Table 4.9-2: Description of soil properties for Wind Erosion Group (WEG) and associated soil erodibility (I) values

WEG	I (ton/acre/yr)	Description
1	310 250 220 180 160	Very fine sand, fine sand, sand or coarse sand
2	134	Loamy very fine sand, loamy fine sand, loamy sand, loamy coarse sand; very fine sandy loam and silt loam with 5% or less clay and 25% or less very fine sand; and sapric soil materials except folists.
3	86	Very fine sandy loam, fine sandy loam, sandy loam, coarse sandy loam, and noncalcareous silt loam that has 20% to 50% very fine sand and 5 to 12% clay
4	86	Clay, silty clay, noncalcareous clay loam that has more than 35% clay, and noncalcareous silty clay loam that has more than 35% clay. All of these do not have sesquic, parasesquic, ferritic, ferruginous, or kaolinitic mineralogy (high iron oxide content). Calcareous loam, calcareous silt loam, calcareous silt, calcareous sandy clay, calcareous sandy clay loam, calcareous clay loam and calcareous silty clay loam.
5	56	Noncalcareous loam that has less than 20% clay; noncalcareous silt loam with 12 to 20% clay; noncalcareous sandy clay loam; noncalcareous sandy clay; and hemic materials.
6	48	Noncalcareous loam and silt loam that have more than 20%clay; noncalcareous clay loam and noncalcareous silty clay loam that has less than 35% clay; silt loam that has parasesquic, ferritic, or kaolinitic mineralogy (high iron oxide content)
7	38	Noncalcareous silt; noncalcareous silty clay, noncalcareous silty clay loam, and noncalcareous clay that have sesquic, parasesquic, ferritic, ferruginous, or kaolinitic mineralogy (high content of iron oxide) and are Oxisols or Ultisols; and fibric material
8	0	Soils not susceptible to wind erosion due to rock and pararock fragments at the surface and/or wetness; and folists

Table 4.9-3 Descriptions of National land Cover Dataset (NLCD) classification

Code	Description
11. Open Water	All areas of open water, generally with less than 25% cover of vegetation/land cover.
12. Perennial Ice/Snow	All areas characterized by year-long surface cover of ice and/or snow.
21. Low Intensity Residential	Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80% of the cover. Vegetation may account for 20 to 70% of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.
22. High Intensity Residential	Includes highly developed areas where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20% of the cover. Constructed materials account for 80 to100% of the cover.
23.Commercial/Industrial /Transportation	Includes infrastructure (e.g. roads, railroads, etc.) and all highly developed areas not classified as High Intensity Residential.
31. Bare Rock/Sand/Clay	Perennially barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, beaches, and other accumulations of earthen material.
32. Quarries/Strip Mines/Gravel Pits	Areas of extractive mining activities with significant surface expression.
33. Transitional	Areas of sparse vegetative cover (less than 25% of cover) that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clear-cuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.).
41. Deciduous Forest	Areas dominated by trees where 75% or more of the tree species shed foliage simultaneously in response to seasonal change.
42. Evergreen Forest	Areas dominated by trees where 75% or more of the tree species `maintain their leaves all year. Canopy is never without green foliage.
43. Mixed Forest	Areas dominated by trees where neither deciduous nor evergreen species represent more than 75% of the cover present.
51. Shrubland	Areas dominated by shrubs; shrub canopy accounts for 25-100% of the cover. Shrub cover is generally greater than 25% when tree cover is less than 25%. Shrub cover may be less than 25% in cases when the cover of other life forms (e.g. herbaceous or tree) is less than 25% and shrubs cover exceeds the cover of the other life forms.
61. Orchards/Vineyards /Other	Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.
71. Grasslands /Herbaceous	Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25%, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.
81. Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
82. Row Crops	Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.
83. Small Grains	Areas used for the production of graminoid crops such as wheat, barley, oats, and rice.
84. Fallow	Areas used for the production of crops that do not exhibit visible vegetation as a result of being tilled in a management practice that incorporates prescribed alternation between cropping and tillage.
85. Urban/Recreational Grasses	Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.
91. Woody Wetlands	Areas where forest or shrubland vegetation accounts for 25-100% of the cover and the soil or substrate is periodically saturated with or covered with water.
92. Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for 75-100% of the cover and the soil or substrate is periodically saturated with or covered with water.

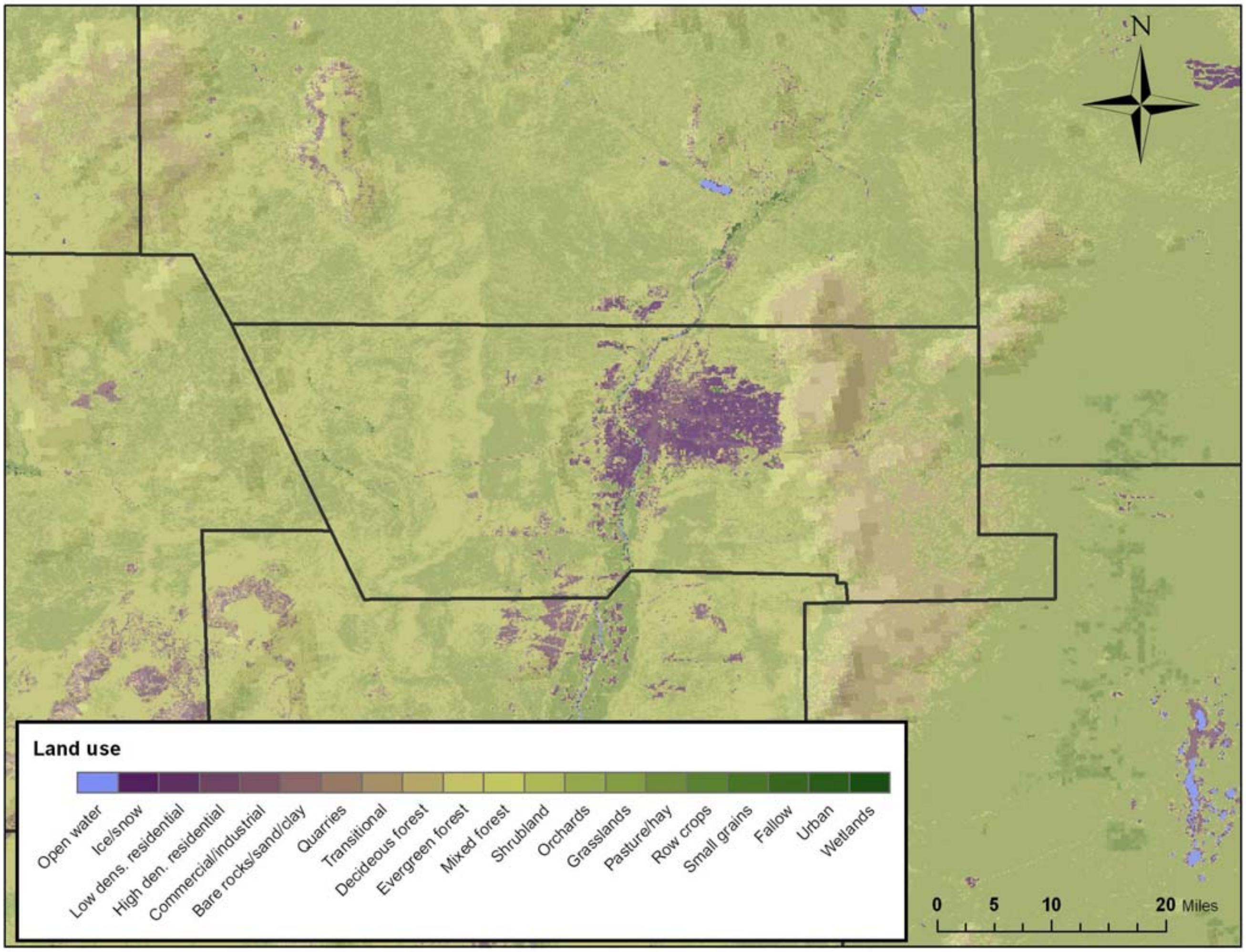


Figure 4.9-2 Landuse for Bernalillo County

County-level agricultural data are obtained from the 2004 New Mexico Agricultural Statistics. Table 4.9-4 shows the area and soil erodibility values used for Bernalillo County, NM.

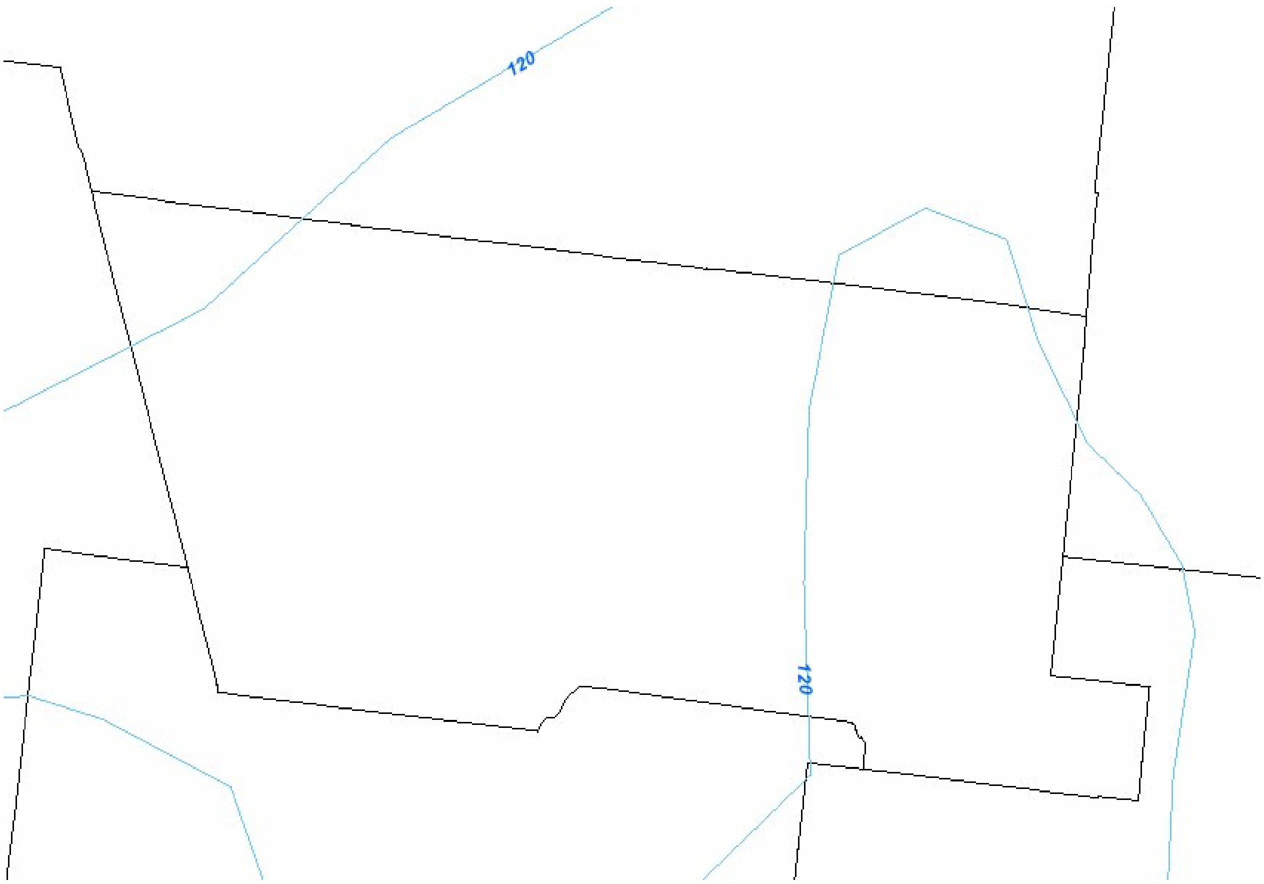
Table 4.9-4 Area and soil erodibility for different type of windblown dust sources in Bernalillo County, NM

Source	Area (in acres)	Soil erodibility, I (in ton/acre)
Agricultural (Alfalfa)	3,000	86
Agricultural (Other hay)	1,500	86
Unpaved roads	879	56
Shrublands/grasslands	515,365	89
Forest	154,920	65

4.9.3 Climatic Factor (C)

Soil erosion depends on wind velocity and soil surface moisture. The climatic factor is used to adjust for these parameters. Data were retrieved from National Resource Conservation Service.

Figure 4.9-3 Annual "C" values of the Wind Erosion Equation for Bernalillo County, NM



4.9.4 Surface Roughness (K)

The K factor (a product of K_{rd} and K_{rr}) is used to account for ridges or furrows that help to minimize wind erosion. For agricultural fields, K is estimated based on the prevailing wind conditions, orientations of fields and tillage and, residue after harvest. K_{rd} is a measure of the effect of ridges made by tillage and planting implements. Ridges absorb and deflect wind energy and trap moving soil particles. The K_r value is based on a standard ridge height to ridge spacing ratio of 1:4. Because of the difficulty of determining surface roughness by measuring surface obstructions, a standard roughness calibration using non-erodible gravel ridges in a wind tunnel was developed. The K_r curves are the basis for charts and tables used to determine K_{rd} factor values in the field. The effect of ridges varies as the wind direction and erodibility of the soil change. To take into account the change in wind directions across a field, we consider the angle of deviation. The angle of deviation is the angle between the prevailing wind erosion direction and a line perpendicular to the row direction. The angle of deviation is 0 (zero) degrees when the wind is perpendicular to the row and is 90 degrees when the wind is parallel to the row. The K_{rr} factor accounts for random roughness. Random roughness is the non-oriented surface roughness that is sometimes referred to as cloddiness. Random roughness is usually created by the action of tillage implements. It is described as the standard deviation (in inches) of the soil surface elevations, measured at regular intervals from a fixed, arbitrary plane above a tilled soil surface, after oriented (ridge) roughness has been accounted for. Random roughness can reduce erosion significantly. Random roughness values have been developed for various levels of WEQ I factor values and surface random roughness. The values of the K-factor for agricultural fields are calculated using the National version of the WEQ model. For forest, open areas and upaved roads the K-factor is assumed to be 1.00.

Table 4.9-5 Values of K factor for different source types

Source	K
Agricultural (Alfalfa)	0.78
Agricultural (Other hay)	0.52
Forest	1.00
Shrublands/grasslands	1.00
Unpaved roads	1.00

4.9.5 Unsheltered Field Width Factor (L)

The L factor represents the unsheltered distance along the prevailing wind erosion direction for the field or area to be evaluated. Its place in the equation is to relate the isolated unsheltered and wide field condition of I to the size and shape of the field. Because V is considered after L in the 5-step solution of the WEQ equation, the unsheltered distance is always considered as if the field were bare except for vegetative barriers. L can be measured directly on a map or calculated using a wind erosion direction factor. The values of the L-factor for agricultural fields are calculated using the National version of the WEQ model. For unpaved roads, depending on the wind direction, the width of the erosive area parallel to the wind direction could be very narrow, very long, or somewhere in between. For an effective L factor, it may be assumed that wind direction is equally distributed for all roads. For this category, an approximate width of the roads of 20 ft is used for the L factor, considering also the prevailing land use in the proximity of unpaved roads. For open areas, the L factor is assumed to be 1000 ft, while for forest, a value of 100 ft is assumed.

4.9.6 Vegetative Cover Factor (V)

The effect of vegetative cover in the WEQ equation is expressed by relating the kind, amount, and orientation of vegetative material to its equivalent in pounds per acre of small grain residue in reference condition Small Grain Equivalent (SGe). This condition is defined as 10 inch long stalks of small grain, parallel to the wind, lying flat in rows spaced 10 inches apart, perpendicular to the wind. Several crops have been tested in the wind tunnel to determine their SGe. Position and anchoring of residue is important. In general, the finer and more upright the residue, the more effective it is for reducing wind erosion. Knowledge of these and other relationships can be used with benchmark values to estimate additional SGe values. Amounts of vegetation may be predicted from production records or estimates and these amounts are then reduced by the expected or planned tillage. If you encounter a crop, residue, or a type of vegetation for which an SGe curve has not been developed. The values of the V-factor for agricultural fields are calculated using the National version of the WEQ model. For unpaved roads and open areas, the V factor is assumed to be 0 lbs/ac, while for forest, a value of 3000 lb/acre is assumed.

Table 4.9-6 shows the PM_{10} emissions of soil dust due to wind erosion of different types of soil for 2004 in Bernalillo County, NM. In total, 280,402 tons of PM_{10} per year dust is entrained to the air. Emissions from open areas (classified as shrubland and grasslands areas in NLCD 2001) are the predominant sources of PM_{10} windblown dust. Wind erosion from unpaved roads accounted for 105 tons of PM_{10} per year. Emissions from vegetated agricultural fields and forests are negligible.

Table 4.9-6 Total emissions of PM_{10} from windblown dust

Source	PM_{10} emissions (in tons/year)
Agricultural (Alfalfa)	0
Agricultural (Other hay)	0
Forest	0
Shrublands/grasslands	280,297
Unpaved roads	105
Total	280,402

5. POINT SOURCE PM_{10}

This category includes point sources included in the local New Source Review permitting database. Emissions are in annual tons per year of allowable PM_{10}. Major point sources of PM_{10} in the county include, LaFarge processing, Volcan processing, Centex wallboard plant, the Reeves and the Delta-Cobisa power stations. Table 5-1 lists the top five point source emitters in the county. Figure 5-1 shows all of the point sources included in this inventory.

Table 5-1 Top five facility-wide point source PM_{10} emissions

Source	PM_{10} emissions (tons/year)
PNM Reeves Generating Station	105
American Gypsum Co.	58
Vulcan Materials, hot mix asphalt and concrete plants	53
Osuna hot mix asphalt plant	37
General Mills Operations, Inc.	36

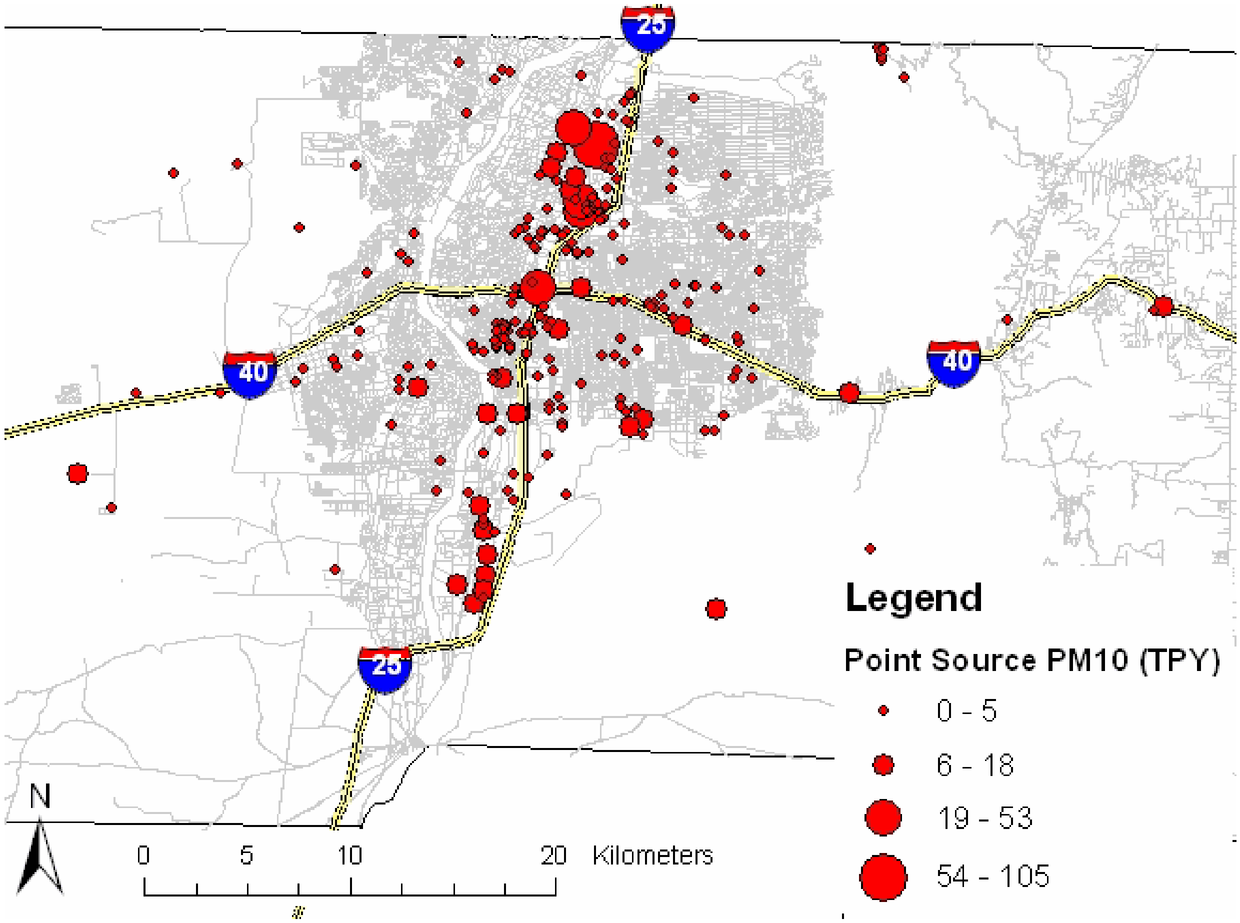


Figure 5-1. Point sources summarized for this inventory and their associated annual PM_{10} emissions.

The Cobisa plant is a natural gas fired power plant capable of 140MW of electrical generation from a General Electric PG7241 (simple-cycle GE 7FA) combustion turbine-generator. The plant is a peaking facility, with operation during periods of high electrical demand or during periods deemed profitable. The plant has been operation since 2000 in the south valley. In 2004 the turbine operated 70 hours (USEPA, 2006).

The PNM Reeves Generating Station consists of three natural gas-fired units capable of 154MW. This plant is located in north Albuquerque near Jefferson and Paseo del Norte and started operation in 1958. This is also a peaking facility as well as for transmission support. In 2004 units 1, 2 and 3 operated 946, 908 and 1526 hours respectively (USEPA, 2006).

Based on the point source database provided by the COA Air Quality Division, point sources contribute 593 tons per year of PM_{10} to the county total.

6. AMMONIA EMISSIONS

Eight ammonia source categories are inventoried, namely

- Livestock

- Cattle and cows
- Pigs and hogs
- Sheep, lambs and goats
- Horses
- Fertilizer Use
  - Anhydrous ammonia
  - Ammonium nitrate
  - Ammonium sulfate
  - Ammonium thio-sulfate
  - Calcium ammonium nitrate
  - Nitrogen solutions
  - Urea
  - Ammonium phosphates nitrate
  - Potassium nitrate
- Humans
  - Respiration and perspiration
- Pets
  - Dogs
  - Cats
- Wild life
  - Black Bear
  - Deer
  - Elk
- Publicly-Owned Treatment Works (POTW)
- Soil
  - Urban and built-up
  - Forest
  - Shrub land and grasslands
  - Wetlands
  - Other
- Mobile sources
- Wildfires

6.1 Livestock

Ammonia emissions are estimated based on annual average animal populations for Bernalillo County. The estimation did not account for regional differences in population and meteorological parameters that can affect emissions and it does not estimate seasonal variations in ammonia emissions. The ammonia emission calculation methodology consisted of three steps, as follows:

- Determine population of animals (beef, dairy, swine, poultry, sheep, goats, horses) for 2004.
- Identify animal populations for beef, dairy, to a manure management train (MMT). Swine populations are only estimated for open confinement areas because there are less than 200

heads per farm. Animal populations for sheep, goats, and horses are not analyzed for different MMTs.

- Estimate county-level emissions from each MMT using emission factors obtained from literature. A composite emission factor is used for swine (open confinement areas, sheep, goats, horses and specific MMT operation for cattle.

The major limitations to estimate county-level emissions include:

- county-level data on animal populations and manure management practices;
- limited published data on ammonia emission factors for animal operations;
- emission factors do not consider the influence of other parameters such as diurnal and seasonal emission patterns, feeding practices, animal life stage, and individual animal management practices.

6.1.1 Activity Data

County-level animal headcounts for cattle, milk and beef cows and, sheep and lambs, are obtained from the USDA National Agricultural Statistic Services 2002 Census (USDA, 2002a) and 2004 New Mexico Agricultural Statistics (NMDA, 2004). To account for cattle inventory changes during a year, a scaling factor was used (EPA, 2004) based on USDA January and July inventory data. These factors are presented in Table 6.1-1. Annual horse and swine populations are retrieved from USDA 2002a Agricultural Census. Population data for poultry are not available in both databases, thus emissions from poultry are not calculated.

Table 6.1-1 Activity data for livestock

Livestock category	Number of heads
Beef cows	3,000
Other cattle	2,000
Milk cows	4,000
Breeding pigs	17
Other pigs	100
Horses and ponies	2,496
Sheep and lambs	1,000
Goats	505

Statewide data on MMT distribution are retrieved from USEPA (2004) and based on USDA (2003a,b) and USDA (2002b). Swine populations are only estimated for open confinement areas because there are less than 200 heads per farm. Animal populations for sheep, goats, and horses are not analyzed for different MMTs. The MMT are presented in Table 6.1-2.

Table 6.1-2 Percentage of farms using different manure management trains per livestock category

Livestock	Manure management train (MMT)	% Farms
Beef cows	Dry lots	100
Other cattle	Dry lots	100
Milk cows	Flash burn	30
	Flash Burn with Solids separation	15
	Scrape Burn	30
	Scrape Burn with Solids separation	15
	Daily Spread	10
Breeding pigs	Outdoor Confinement Area	100
Other pigs	Outdoor Confinement Area	100

6.1.2 Emission Factor

Emission factors are obtained for each manure management train (MMTs) expressed in kilograms of ammonia emitted per head per year (in kg NH_3 / head / year) and the percentage of nitrogen lost as ammonia. Emission factors (EF_{MMT}) data are obtained from USEPA (2001, 2002) and NRC (2003). They are presented in Table 6.1-3.

Table 6.1-3 Average live weight (ALW), $N_{excrertionrate}$, Emission factor and % N loss per MMT for each livestock category

Livestock	MMT	ALW kg	$N_{excretion\ rate}$ kg/day	Emission Factor kg NH_3/head/year	% N loss
Beef cows	Dry lots			8.43	
Other cattle	Dry lots			8.43	
Milk cows	Flash burn	604.20	0.45		23.50
	Flash Burn with Solids separation	604.20	0.45		23.80
	Scrape Burn			8.16	
	Scrape Burn with Solids separation			8.16	
	Daily Spread			8.43	
Breeding pigs	Outdoor Confinement Area	198.20	0.24		16.60
Other pigs	Outdoor Confinement Area	67.60	0.42		16.60
Horses				12.20	
Sheep and lambs				3.37	
Goats				6.40	

To estimate the loss of nitrogen in the form of ammonia, the amount of excreted nitrogen per day ($N_{excreted,MMT}$ in kg / day) is calculated as follows:

$$N_{excreted,MMT} = Pop_{MMT} \cdot ALW \cdot N_{rate}$$

where Pop_{MMT} is the population for each MMT (in heads), ALW is the average live weight (in kg / head) and N_{rate} is the nitrogen excretion rate (in kg/1000 kg of animal mass / day).

6.1.3 Emission Estimate

Ammonia emissions from each MMT per animal category using emission factor of ammonia per head are estimated as follows:

$$NH_{3,(MMT)} = Pop_{MMT} \cdot EF_{MMT}$$

where $NH_{3,MMT}$ is the estimated ammonia emissions from a particular MMT (in kg NH_3 / year), $Pop._{MMT}$ is the animal population in particular MMT (in heads), calculated and EF_{MMT} is the emission factor (in kg NH_3 / head / year) of the MMT.

Alternatively, ammonia emissions from a MMT using the percentage of nitrogen lost as ammonia are calculated as follows:

$$NH_{3,(MMT)} = N_{excreted,MMT} \cdot \%N\ Loss \cdot \frac{17}{14}$$

where $NH_{3,MMT}$ is the estimated ammonia emission from a particular MMT (in kg NH_3 / year), $N_{excreted,MMT}$ is the nitrogen excreted/managed in a particular MMT , %N Loss is the percentage of N lost as ammonia for the MMT and 17/14 is the conversion factor of nitrogen to ammonia. The emissions from a complete MMT are estimated as the sum of the emissions from each component.

6.2 Fertilizer Use

6.2.1 Activity Data

Data for 2002 fertilizer use are obtained from the latest CMU NH_3 emission model (Strader, 2004), adjusted by 17% increase of fertilizer nutrition consumption (AAPFCO, 2006). A complete list of fertilizer use is presented in Table 6.2-1

Table 6.2-1 Estimated fertilizers use in Bernalillo County, NM for 2004

Fertilizer	Fertilizer quantity used kg	% Nitrogen content
Anhydrous ammonia	305,735	82.00
Ammonium nitrate	20,445	42.80
Ammonium sulfate	135,731	21.00
Ammonium thiosulfate	33,833	12.00
Calcium ammonium nitrate	10,783	26.60
Nitrogen solutions	889,476	33.90
Urea	313,387	45.90
Ammonium phosphates nitrate	2,658,014	15.50
Potassium nitrate	488	15.10

6.2.2 Emission Factor

Emission factors ($EF_{fertilizer}$) are retrieved from the EEA (2002) Joint EMEP/CORINAIR Atmospheric Emission Inventory Guidebook, Third Edition. Copenhagen: European Environment Agency and the. Battye R., Battye W., Overcash C., and Fudge S., 1994. "Development and selection of ammonia emission factors." Prepared by EC/R, Inc for the US-EPA Atmospheric Research and Exposure Assessment Laboratory. Although NH_3 concentration levels depend upon the soil pH, previous studies showed that the use of pH-adjusted emission factors result in insignificant changes in NH_3 emissions from fertilizers (WRAP, 2005, An Improved Ammonia Inventory for the WRAP Domain Final Report, Volume I). Emission factor for each fertilizer are presented in Table 6.2-2.

Table 6.2-2 Emission factors for each fertilizer

Fertilizer	Emission Factor (kg NH_3 / kg N-fertilized / year)
Anhydrous ammonia	4.00
Ammonium nitrate	3.00
Ammonium sulfate	15.00
Ammonium thiosulfate	2.50
Calcium ammonium nitrate	3.00
Nitrogen solutions	8.00
Urea	20.00
Ammonium phosphates nitrate	5.00
Potassium nitrate	2.00

6.2.3 Emission Estimate

Ammonia emissions from each fertilizer are estimated as follows:

$$NH_{3,fertilizer} = Use_{fertilizer} \cdot \%Nitrogen \cdot EF_{fertilizer}$$

where $NH_{3,fertilizer}$ is the estimated ammonia emissions from a specific fertilizer (in kg NH_3 / year), $Use_{fertilizer}$ is the quantity of fertilizer used (in kg of fertilizer), and EF_{MMT} is the emission factor (in kg NH_3 / kg of N-fertilizer / year).

6.3 Humans

6.3.1 Activity Data

Bernalillo County 2004 population data are obtained from the Population Estimates Program of the US Census Bureau (2005). The 2004 projected population is 593,765 inhabitants for Bernalillo County.

6.3.2 Emission Factor

Emission factors are retrieved from Battye R., Battye W., Overcash C., and Fudge S., 1994. "Development and selection of ammonia emission factors." Prepared by EC/R, Inc for the US-EPA Atmospheric Research and Exposure Assessment Laboratory, Table 6.1. The emission factor from breathing (Respiration and perspiration) presented is 0.25 kg NH_3 / person / year.

6.3.3 Emission Estimate

Ammonia emissions from each fertilizer are estimated as follows:

$$NH_{3,humans} = Pop_{2004} \cdot EF_{human}$$

where $NH_{3,humans}$ is the estimated ammonia emissions from breathing (in kg NH_3/year), Pop. is the 2004 projected population for Bernalillo County and EF_{human} is the emission factor (in kg NH_3/person/year.

6.4 Wildlife

6.4.1 Activity Data

Black and grizzly bears, elk and dears are included in the emission inventory. Data of wild animal population are obtained from the latest version of the Carnegie Mellon University (CMU) NH_3 Model (Strader, et al., 2004). County level wild animal activity data (number of animals) are presented in Table 6.4-1.

Table 6.4-1 Population of each wild animal category

Wild Animal	Population
Black bears	49
Deer	123
Elk	738

6.4.2 Emission Factor

Emission factors are retrieved from Kirchstetter and Brown (2003), the ammonia emissions inventory for the state of Wyoming and the Bureau of Land Management, Department of Interior. The emission factors are presented in Table 6.4-2.

Table 6.4-2 Emission factors for each wild animal category

Wild Animal	Emission Factor
	kg NH_3 / animal / year
Black bears	66.1
Deer	4.8
Elk	17.2

6.4.3 Emission Estimate

Ammonia emissions from each fertilizer are estimated as follows:

$$NH_{3,\,wildanimal} = Pop_{wildanimal} \cdot EF_{wildanimal}$$

where $NH_{3,wildanimal}$ is the estimated ammonia emissions from each wild animal group (in kg NH_3 / year), $Pop_{wildanimal}$ is the population of each wild animal group and $EF_{wildanimal}$ is the emission factor (in kg NH_3 / animal / year.

6.5 Pets

6.5.1 Activity Data

The number of pets (dogs and cats) is estimated based on US Census 2000 data and from American Veterinary Medical Association, Schaumburg, IL, U.S. Pet Ownership and Demographics Sourcebook, 2002 as of December 31, 2001. In particular, the number of households in Bernalillo County is estimated based on the 2004 projected population divided by 2.47 persons per household (US Census 2000). The number of households owning at least one pet and the average number of pets per household were obtained from American Veterinary

Medical Association, Schaumburg, IL, U.S. Pet Ownership and Demographics Sourcebook, 2002 as of December 31, 2001. Thus, the 2004 projected pet population is estimated as follows:

$$Pop_{pet} = (HSH \cdot \frac{\%HSHPET}{100}) \cdot APH$$

where Pop_{pet} is the estimated population for each pet category (in heads), HSH is the number of households, %HSHPET is the percentage of household with pets and APH is the average number of pets per household. The population per pet in Bernalillo County is presented in Table 6.5-1

Table 6.5-1 Population of pets in Bernalillo County, NM

Pet	Number of Pets
Cats	159,522
Dogs	138,849

6.5.2 Emission Factor

Emission factors are retrieved from Battye R., Battye W., Overcash C., and Fudge S., 1994. "Development and selection of ammonia emission factors." Prepared by EC/R, Inc for the US-EPA Atmospheric Research and Exposure Assessment Laboratory. Emission factors are presented in Table 6.5-2.

Table 6.5-2 Emission factors for each pet category

Pet	Emission fctor
	kg NH_3 / pets / year
Cats	0.66
Dogs	1.98

6.5.3 Emission Estimate

Ammonia emissions from each fertilizer are estimated as follows:

$$NH_{3,pet} = Pop_{pet} \cdot EF_{pet}$$

where $NH_{3,pet}$ is the estimated ammonia emissions from each pet category (in kg / year), Pop_{pet} (in heads) is the population of each wild animal group and EF_{pet} is the emission factor (in kg NH_3 / heads / year).

6.6 Publically Owned Treatment Works (POTW)

6.6.1 Activity Data

One POTW is operating in Bernalillo County. Activity data are obtained from Clean Watersheds Needs Survey (USEPA, 2000). Although the design flow for the POTWs is 78.38 millions of gallons per day, the existing flow is 47.9 millions of gallons per day, thus 17,483.00 millions of gallons per year.

6.6.2 Emission Factor

An emission factor of 0.05 kg NH_3 / million of gallon is obtained from research results published by Kogan and Torres (1997).

6.6.3 Emission Estimate

Ammonia emissions from the POTW are estimated as follows:

$$NH_{3,POTW} = AF_{POTW} \cdot EF_{POTW}$$

where $NH_{3,POTW}$ is the estimated ammonia emissions from POTW (in kg NH_3 / year), AF_{POTW}. is the annual flow in POTW (in millions of gallons / year) and EF_{POTW} is the emission factor (in kg NH_3 / million of gallons).

6.7 Soil

6.7.1 Activity Data

The National Land Cover Characterization 2001 (NLCD, 2001) database is obtained from the USGS. The database provides a gridded 30 m by 30 m delineation of land use using 19 categories as they are presented in Table 6.7-1.

Table 6.7-1 Description of each land use in the National Land Cover Database

Code	Description
11. Open Water	All areas of open water, generally with less than 25% cover of vegetation/land cover.
12. Perennial Ice/Snow	All areas characterized by year-long surface cover of ice and/or snow.
21. Low Intensity Residential	Includes areas with a mixture of constructed materials and vegetation. Constructed materials account for 30-80% of the cover. Vegetation may account for 20 to 70% of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high intensity residential areas.
22. High Intensity Residential	Includes highly developed areas where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20% of the cover. Constructed materials account for 80 to100% of the cover.
23.Commercial/Industrial /Transportation	Includes infrastructure (e.g. roads, railroads, etc.) and all highly developed areas not classified as High Intensity Residential.
31. Bare Rock/Sand/Clay	Perennially barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, beaches, and other accumulations of earthen material.

Table 6.7-1 Description of each land use in the National Land Cover Database (Continued)

Code	Description
32. Quarries/Strip Mines/Gravel Pits	Areas of extractive mining activities with significant surface expression.
33. Transitional	Areas of sparse vegetative cover (less than 25% of cover) that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g. fire, flood, etc.).
41. Deciduous Forest	Areas dominated by trees where 75% or more of the tree species shed foliage simultaneously in response to seasonal change.
42. Evergreen Forest	Areas dominated by trees where 75% or more of the tree species `maintain their leaves all year. Canopy is never without green foliage.
43. Mixed Forest	Areas dominated by trees where neither deciduous nor evergreen species represent more than 75% of the cover present.
51. Shrubland	Areas dominated by shrubs; shrub canopy accounts for 25-100% of the cover. Shrub cover is generally greater than 25% when tree cover is less than 25%. Shrub cover may be less than 25% in cases when the cover of other life forms (e.g. herbaceous or tree) is less than 25% and shrubs cover exceeds the cover of the other life forms.
61. Orchards/Vineyards /Other	Orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.
71. Grasslands /Herbaceous	Areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25%, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but they are often utilized for grazing.
81. Pasture/Hay	Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.
82. Row Crops	Areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.
83. Small Grains	Areas used for the production of graminoid crops such as wheat, barley, oats, and rice.
84. Fallow	Areas used for the production of crops that do not exhibit visible vegetation as a result of being tilled in a management practice that incorporates prescribed alternation between cropping and tillage.
85. Urban/Recreational Grasses	Vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.
91. Woody Wetlands	Areas where forest or shrubland vegetation accounts for 25-100% of the cover and the soil or substrate is periodically saturated with or covered with water.
92. Emergent Herbaceous Wetlands	Areas where perennial herbaceous vegetation accounts for 75-100% of the cover and the soil or substrate is periodically saturated with or covered with water.

Land cover class definitions are obtained from http://landcover.usgs.gov/classes.asp. The spatial variation of land use classes for Bernalillo County are depicted in Figure 6.7-1.

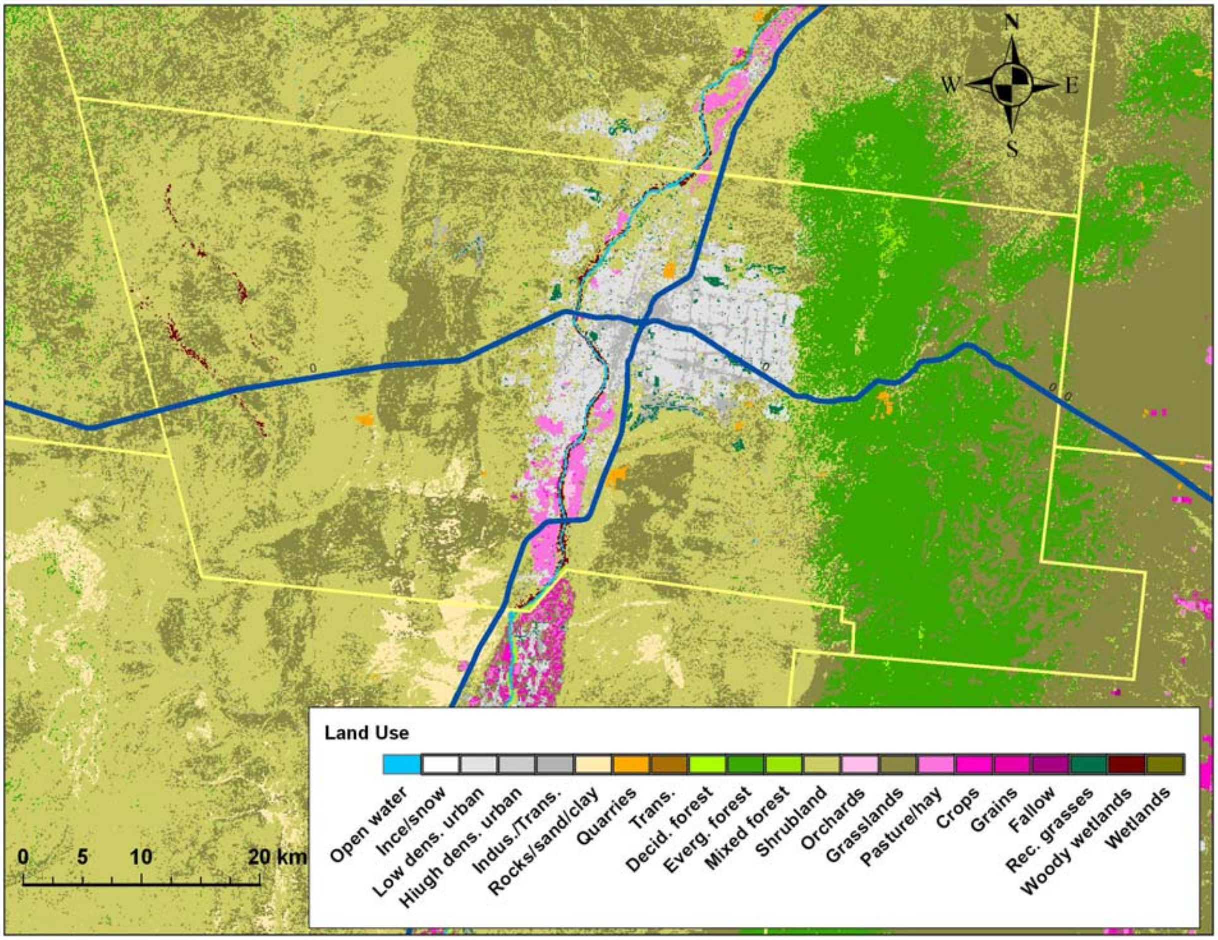


Figure 6.7-1 Spatial variation of land use in Bernalillo County

The NLCD 2001 land use categories are combined in six soil-type categories based on available emission factor data. The area covered by each soil type is presented in Table 6.7-2. Agricultural lands are not included in this analysis, because of the estimation of fertilizers.

Table 6.7-2 Surface area per soil type in Bernalillo County, NM

Soil Type	Area km^2
Urban	369.0
Shrub- and grasslands	1493.3
Forests	979.3
Wetlands	0.9
Transitional areas	12.7
Other	0.4

6.7.2 Emission Factor

Data to estimate ammonia emissions from different types of soil are sparse. Although ammonia emissions from soil normally dominate an inventory, the estimations are highly uncertain. Emission factors are retrieved from Battye et al., 2003 and Chinkin et al., 2003 (and references herein) and they are presented in Table 6.7-3.

Table 6.7-3 Emission factors for different types of native soil

Soil Type	Area
	kg NH_3 / km^2 / year
Urban	400
Shrub- and grasslands	400
Forests	120
Wetlands	400
Bare soil	370

6.7.3 Emission Estimate

Ammonia emissions from the soils are estimated as follows:

$$NH_{3,soils} = Area_{soils} \cdot EF_{soils}$$

where $NH_{3,soils}$ is the estimated ammonia emissions from soils (in kg NH_3 / year), $Area_{soil}$. is the area surface for a given land use class (in km^2 / year) and EF_{soils} is the emission factor (in kg NH_3 / km^2).

6.8 On-Road Mobile Sources

Inputs, model runs, estimation methods: All discussion in the PM_{10} emission inventory development report will apply.

Total countywide annual NH_3 emissions in Bernalillo County in 2004 were 546 tons/yr. Typical summer day emissions were 1.53 tons/day. Table 6.8-1 summarizes the annual emissions, in tons/yr, by vehicle class and roadway type. Table 6.8-2 summarizes the emissions for a typical summer day, expressed in lbs/day.

Figure 6.8-1 shows a plot of the emissions by roadway and vehicle type, summarized by major classes. Figure 6.8-2 and Figure 6.8-3 present the data in the form of a pie chart showing the distribution of emissions within each vehicle and roadway class. The light duty gasoline cars and trucks (LDGV and LDGT) together contributed about 96% of the annual NH_3 emissions, with the remaining 4% emitted by heavy duty vehicles. The NH_3 emissions typically arise from NOx emission controls that employ catalysts to reduce NOx in the vehicle exhaust, which is more prevalent in light duty cars and trucks. Similar to the case observed in PM_{10} emissions, the majority of emissions occurred on urban arterials (46%) and interstates (28%). As discussed earlier, this is due to the fact that a majority of the VMT (63% of County VMT) occurred on these two roadway classes.

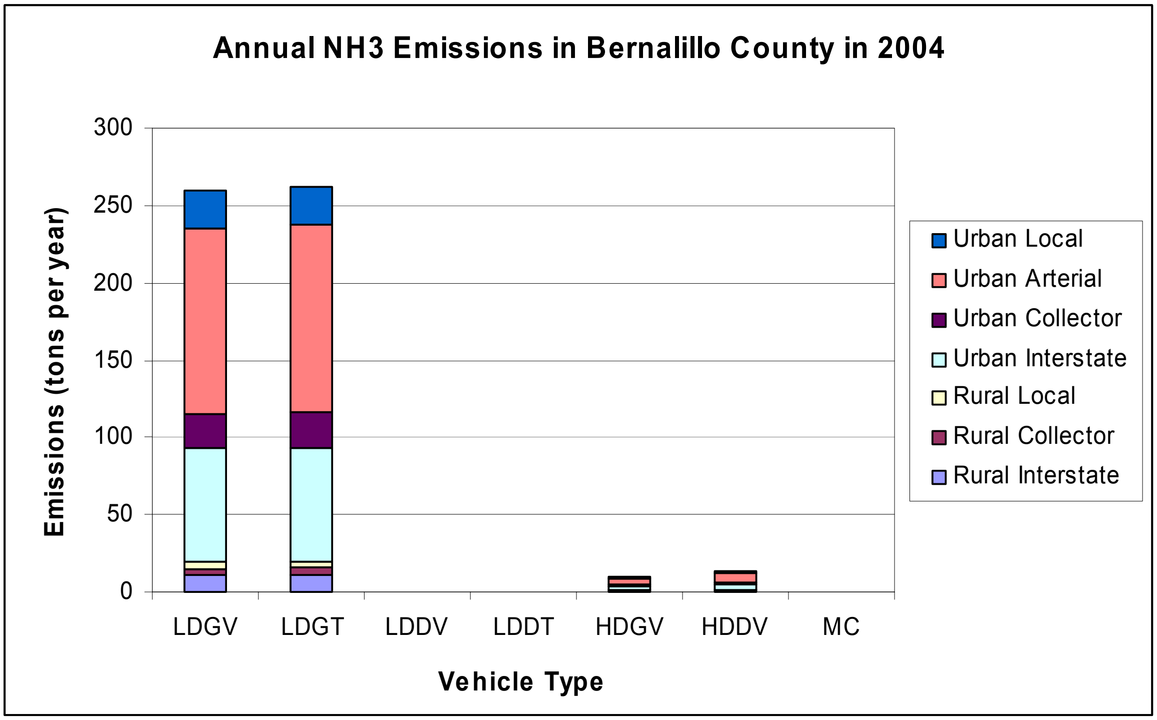


Figure 6.8-1 Annual NH_3 Emissions in Bernalillo County in 2004 by Roadway and Vehicle Type

Table 6.8-1. Annual NH_3 Emissions in Bernalillo County in 2004 by Vehicle Class and Roadway Type (tons/yr)

	Emissions by Vehicle Class (tons/yr)												
Roadway Type	LDGV	LDGT12	LDGT34	HDGV	LDDV	LDDT	HDDV2B	HDDV345	HDDV67	HDDV8AB	HDBST	MC	Grand Total
Rural Interstate	11.087	8.4223	2.7845	0.41385	0.00102	0.00312	0.0637	0.0455	0.1060	0.349	0.0173	0.0166	23.31
Rural Major Collector	2.7620	2.0985	0.69387	0.10312	0.00025	0.00078	0.0159	0.0113	0.0264	0.087	0.0043	0.0041	5.807
Rural Minor Collector	1.3073	0.99325	0.32842	0.04881	0.00012	0.00037	0.0075	0.0054	0.0125	0.0411	0.00204	0.0020	2.749
Rural Local	4.5528	3.4591	1.1437	0.16998	0.0004	0.00128	0.0261	0.0187	0.0435	0.143	0.0071	0.0068	9.573
Urban Interstate	72.780	55.273	18.274	2.7165	0.0067	0.0205	0.4179	0.2983	0.6956	2.289	0.1133	0.1092	153.0
Urban Principal Arterial	89.715	68.105	22.514	3.3478	0.0083	0.0253	0.5150	0.3676	0.8572	2.820	0.1396	0.1346	188.5
Urban Major Arterial	30.177	22.908	7.5731	1.1261	0.00278	0.0085	0.1732	0.1236	0.2883	0.949	0.0470	0.0453	63.42
Urban Collector	22.850	17.346	5.7343	0.85266	0.00210	0.0064	0.1312	0.0936	0.2183	0.718	0.0356	0.0343	48.02
Urban Local	24.383	18.510	6.1192	0.90989	0.00224	0.0069	0.1400	0.0999	0.2330	0.767	0.0379	0.0366	51.25
Grand Total	259.6	197.1	65.17	9.689	0.0239	0.0731	1.490	1.064	2.481	8.163	0.404	0.389	546

Table 6.8-2. Typical Summer Day NH_3 Emissions in Bernalillo County in 2004 by Vehicle Class and Roadway Type (lbs/day)

	Emissions by Vehicle Class (lbs/day)												
Roadway Type	LDGV	LDGT12	LDGT34	HDGV	LDDV	LDDT	HDDV2B	HDDV345	HDDV67	HDDV8AB	HDDBST	MC	Grand Total
Rural Interstate	63.719	48.378	16.051	2.3912	0.00585	0.01791	0.3674	0.2622	0.6109	2.011	0.0992	0.0964	134.01
Rural Major Collector	16.308	12.382	4.1081	0.61198	0.00150	0.00458	0.0940	0.0671	0.1563	0.515	0.0254	0.0247	34.298
Rural Minor Collector	7.7186	5.860	1.9444	0.28966	0.00071	0.00217	0.0445	0.0318	0.0740	0.2436	0.01202	0.0117	16.234
Rural Local	26.881	20.409	6.7716	1.00876	0.0025	0.00756	0.1550	0.1106	0.2577	0.848	0.0419	0.0407	56.535
Urban Interstate	409.03	310.56	103.04	15.350	0.0375	0.1150	2.3588	1.6829	3.9214	12.908	0.6369	0.6191	860.3
Urban Principal Arterial	498.62	378.58	125.61	18.712	0.0458	0.1402	2.8754	2.0515	4.7803	15.736	0.7764	0.7546	1048.7
Urban Major Arterial	167.72	127.34	42.250	6.2940	0.01539	0.0472	0.9672	0.6901	1.6079	5.293	0.2612	0.2538	352.74
Urban Collector	127.00	96.422	31.992	4.7658	0.01166	0.0357	0.7324	0.5225	1.2175	4.008	0.1978	0.1922	267.09
Urban Local	135.52	102.89	34.139	5.0856	0.01244	0.0381	0.7815	0.5576	1.2992	4.277	0.2110	0.2051	285.02
Grand Total	1452.5	1102.8	365.90	54.508	0.1333	0.4084	8.376	5.976	13.925	45.839	2.262	2.198	3055

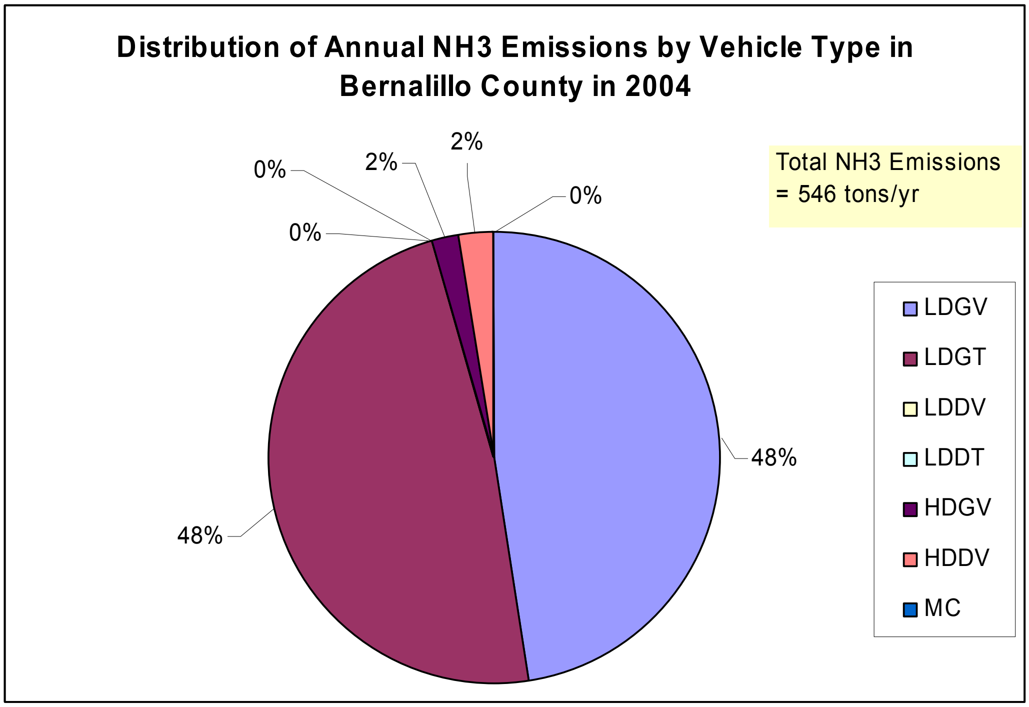


Figure 6.8-2 Distribution of Annual NH_3 Emissions by Vehicle Type in Bernalillo County in 2004

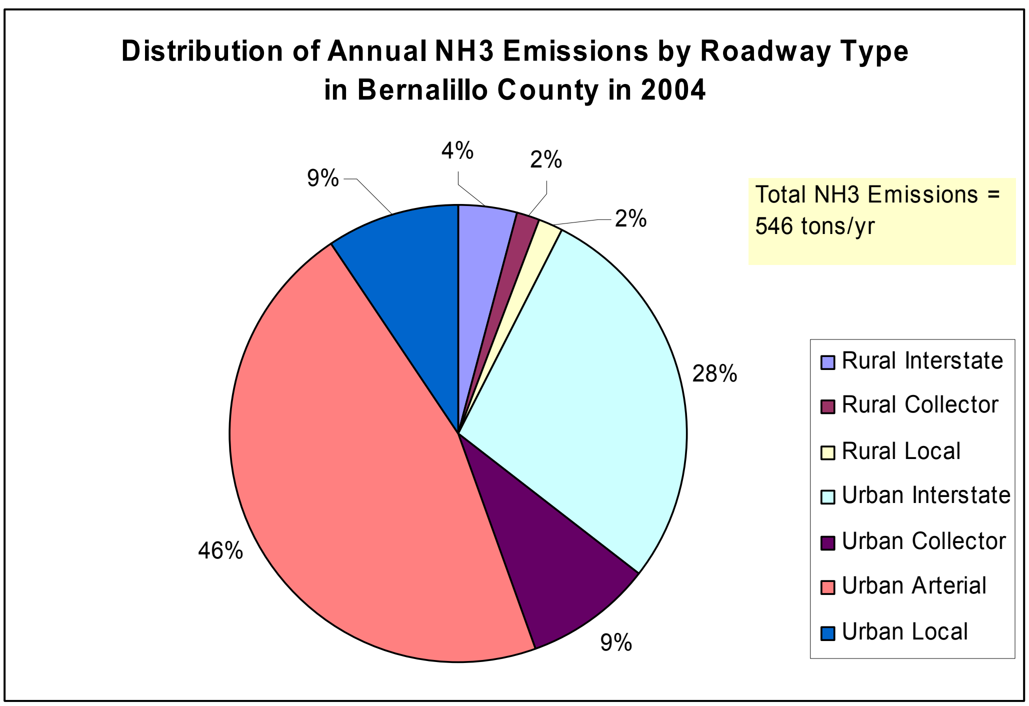


Figure 6.8-3 Distribution of Annual NH_3 Emissions by Roadway Type in Bernalillo County in 2004

6.9 Non-Road Mobile Sources

The NONROAD 2005 model does not estimate NH_3 emissions. Based on the 2001 NH_3 emissions inventory for Bernalillo County (USEPA, 2001) the non-road mobile sources accounted for a negligible fraction (~0.3%) of the total countywide NH_3 emissions. Hence, the NH_3 emissions were imported from the 2002 NEI Draft Non-road inventory, without further adjustments. The NEI draft inventory consisted of only annual emissions. Typical summer day emissions were calculated by taking the ratio of annual PM_{10} to typical summer day (i.e., ozone season day [OSD] emissions in the database) PM_{10} emissions and applying it to the annual NH_3 emissions for each SCC. Since NH_3 is not released through an evaporative emission process, the only difference between the annual and OSD emissions would be due to the difference in activity factors. The approach followed here assumes that the activity factors used in the PM_{10} emission inventory development would apply equally to the NH_3 emission inventory. This is a valid assumption, since both PM_{10} and NH_3 are exhaust pollutants and are not influenced by evaporative processes.

Table 6.9-1 summarizes the NH_3 emissions from non-road mobile sources in Bernalillo County. The annual NH_3 emissions were about 4.2 tons per year. Figure 6.9-1 shows a pie chart of the annual NH_3 emissions from non-road sources. Similar to PM_{10}, construction and mining equipment (44%) followed by commercial and residential use of lawn and gardening equipment (33%) were the two major sources. The third major category, however, was emissions from commercial equipment which include generator sets, pumps and compressors.

Table 6.9-1 Annual (tons/yr) and Summer (lbs/day) NH_3 Emissions from Non-road Mobile Sources in Bernalillo County

	NH_3 Emissions	
Source	**Annual (tons/yr)**	**Summer (lbs/day)**
Agricultural Equipment	0.01710	0.1261
Aircraft	0	0
Airport Equipment	0.03288	0.1787
Commercial Equipment	0.5915	3.215
Construction and Mining Equipment	1.788	10.59
Industrial Equipment	0.3055	1.669
Lawn and Garden Equipment	1.385	9.794
Logging Equipment	0	0
Pleasure Craft	0.009326	0.09741
Railroad Equipment and Locomotives	0.007455	0.04052
Recreational Equipment	0.03610	0.2899
Total	4.17	26.00

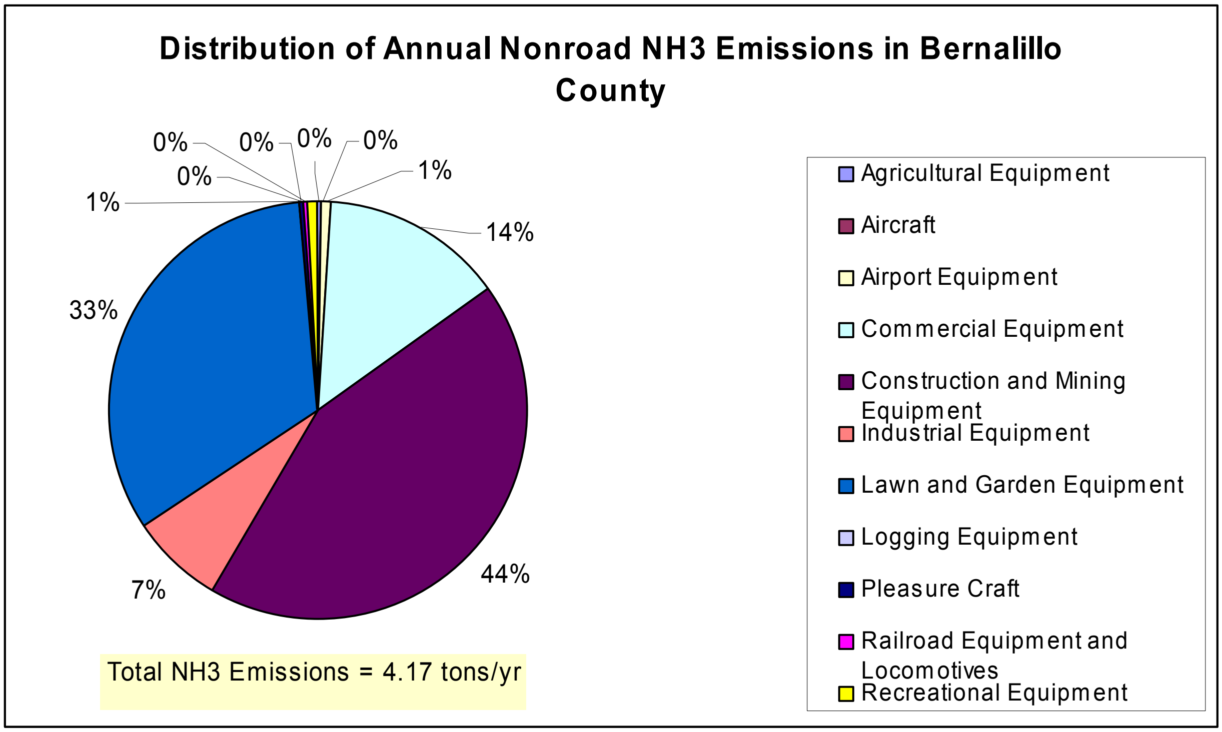


Figure 6.9-1 Distribution of Annual Non-road NH_3 Emissions by Source in Bernalillo County

6.10 Summary

Annual ammonia emissions for 2004 for each of eight source categories are presented in Table 6.10-1. In total, 1,700,063 tons of NH_3 are emitted annually from eight source categories. Soil is the major source of ammonia in Bernalillo County representing approximately 44% of total emissions (Figure 6.10-1)

Table 6.10-1 Total emissions of NH_3 from various sources in this inventory

Category	NH_3 emissions (tons/yr)
Livestock	227,095
Fertilizers	107,156
Human	148,441
Wild life	18,846
Pets	443,564
POTW	944
Soil	753,466
Mobile	550
Total	**1,700,063**

Emissions from animal wastes including pets and livestock accounted for 26% and 13%, respectively. Human breathing contributes 9% of total annual ammonia emissions while estimated ammonia emissions because of the use of fertilizers in agricultural fields are 6% of total annual emissions. Minor amounts (less than 1%) are contributed from wild life manure, publicly owned treatment works and mobile sources.

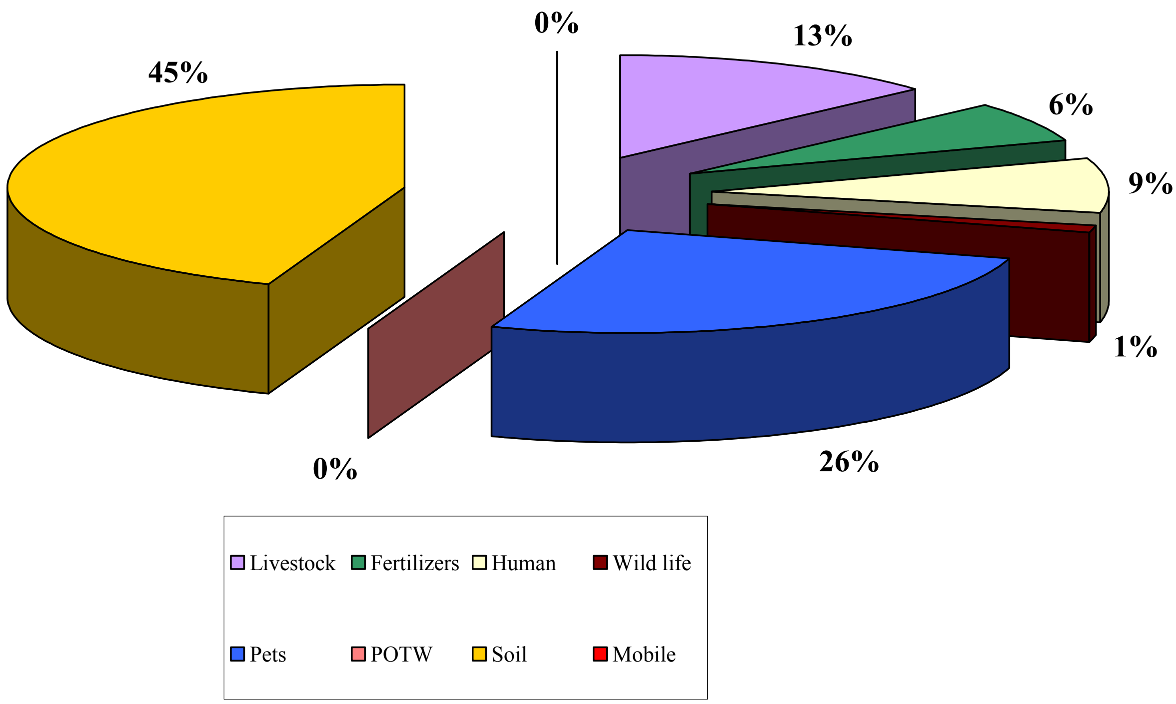


Figure 6.10-1 Percentage NH_3 emissions from different sources

7. CONCLUSIONS

This inventory is not meant to be a complete compilation of all PM_{10} emission sources in Bernalillo County. Rather, it is a first cut at estimating emissions based on best available emission factors and activity at the time of writing.

Table 7-1 summarizes the annual PM_{10} emissions resulting from the major source categories included in this inventory. The top emission source identified in the county is from wind erosion capturing 95 percent of the total PM_{10} emissions on an annual basis. Wind erosion as well as wildfires, prescribed burning, and detonations are episodic emission sources and as a result are not typical emitters on a day-to-day basis. To quantify the day-to-day emissions, Table 7-2 shows the percentage of each source type to the total non-wind erosion PM_{10} emissions. The largest non-wind erosion source is construction that contributes 42 percent of total non-wind erosion total. Residential wood combustion is the second highest contributor to non-wind erosion at 24 percent. The next highest emitter is paved road dust at 14 percent.

Table 7-1 Total emissions of PM_{10} from various sources in this inventory

Source	PM_{10} emissions (in tons/year)
Mobile sources, on-road	367
Mobile sources, non-road	359
Point sources	593
Wildfires	4
Prescribed burning	9
Residential wood burning	3,907
Structural/vehicle fires	2
Open burn/detonations	73
Charbroiling	478
Agricultural tilling and harvesting	5
Agricultural unpaved roads	24
Construction	6,851
Paved road dust	2,274
Unpaved road dust	1,292
Wind erosion	280,402
Total	296,640

Table 7-2 Percent of non wind erosion emissions from various sources in this inventory

Source	Percent of Non-wind erosion PM_{10} emissions (%)
Mobile sources, on-road	2
Mobile sources, non-road	2
Wildfires	0.02
Point sources	4
Prescribed burning	0.06
Residential wood burning	24
Structural/vehicle fires	0.01
Open burn/detonations	0.4
Charbroiling	3
Agricultural tilling & harvesting	0.03
Agricultural unpaved roads	0.1
Construction	42
Paved road dust	14
Unpaved road dust	8

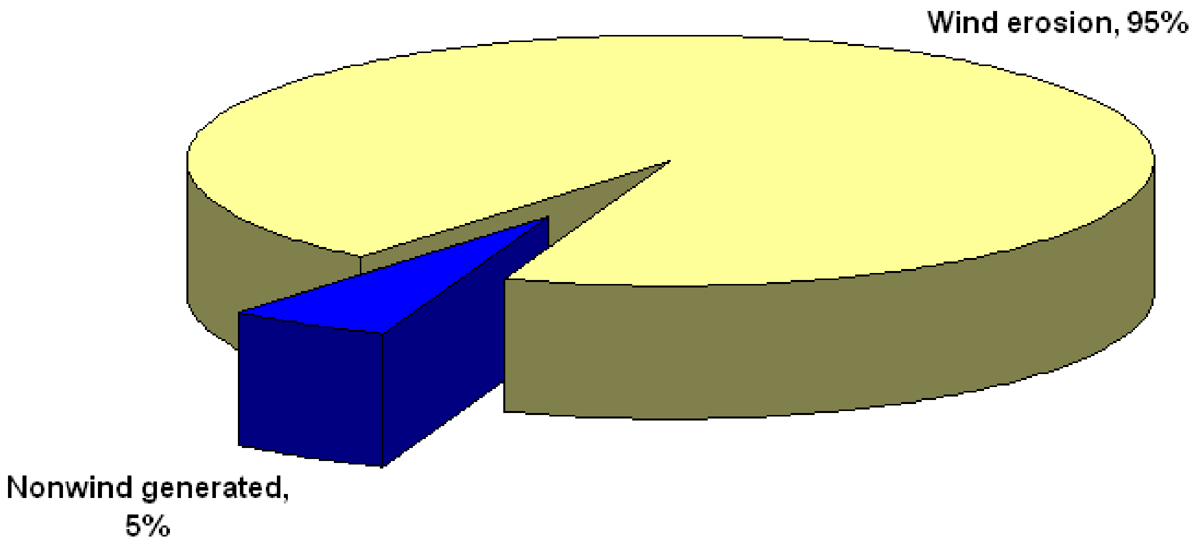


Figure 7-1 Summary of all emissions including windblown dust

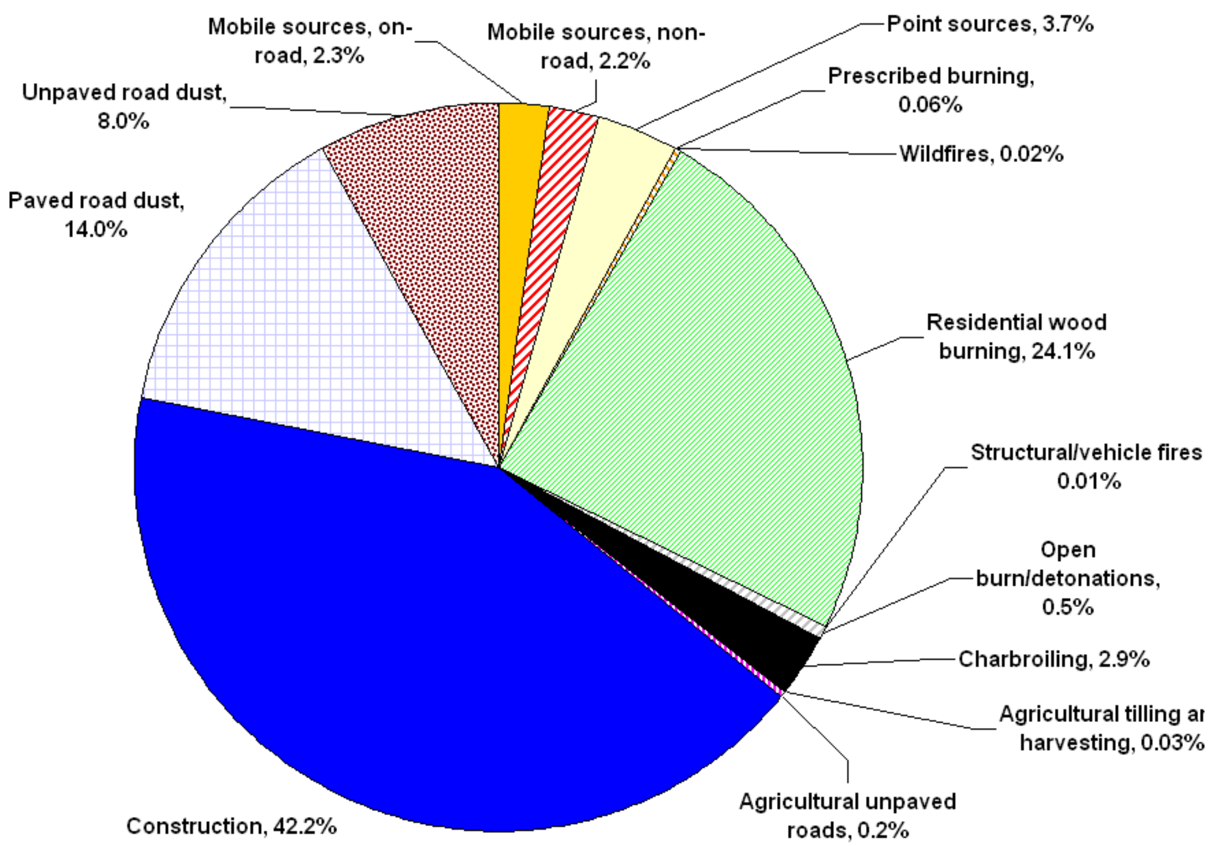


Figure 7-2 Summary of all non windblown PM_{10} emissions in Bernalillo County

8. RECOMMENDATIONS

The quality of an inventory depends on the inputs and assumptions used in developing the inventory. The inherent variability of fugitive dust emissions may preclude absolute emissions estimates. Nevertheless, the examination of physical processes shows that better knowledge of the locations of these emissions, the joint frequencies of activities and different meteorological conditions, and more site specific measurements of key parameters would provide more representative emissions rates than are now available.

Since wind erosion represents the largest PM_{10} emission source in the county on an annual basis, it would be beneficial to refine this source as much as possible. New technologies exist that allow characterization of the wind erodibility of soils with less expense than employing large straight-line wind tunnels. This effort would apply the dust characterization technologies standardized by the research community to representative fugitive dust emitters within each source type with erodible lands. Comparisons would be made with more spatially diverse data, such as those in the soil surveys, to determine the degree to which these surveys can be used to extrapolate the measurements from a reduced number of sampling sites. These values would be incorporated into the emissions inventory to better estimate emissions from specific soil types.

Since construction is the second largest contributor to annual PM_{10} emissions, this source category could be refined using site specific activity data and emission factors. Construction activity information was limited to a date and total acreage based on the dust control permit database. Because of this limitation, the estimation of construction emissions in this inventory were based on emission factor studies in California and Las Vegas, NV. Collecting additional information from the dust control permittees would provide a better emissions estimate from this source. For example, by specifying the amount of earth moving, total project area and duration would give one level of more detail in emission estimation according the WRAP Dust Handbook. While this inventory focused on annual construction emissions, a gridded inventory useful for modeling would require better tracking of locations in the permit database. A useful tracking method could involve the specification of parcel number for the construction project as well as the acreage disturbed.

Paved road dust is an important source sector, contributing 12 percent of the non-wind blown inventory. A better grasp of the levels of suspendable dust on paved roads would improve the inventory. An effort to quantify silt loadings and local conditions would more accurately determine emissions from different classifications of paved roads. Using the results from past research projects on paved road micrometeorology and dust sources, road types would be reclassified in the activity data base by the processes which are likely to be related to emissions. Emission factor studies could be conducted for representatives of these different types, and emission factors that are more closely related to the mechanisms which cause suspension would be developed. These emission factors would be incorporated into a regional emissions inventory system. One method to collect regional paved road emissions is discussed in section 8.2 using a vehicle based mobile emissions sensing system.

Based on several site surveys done for this project, the total unpaved road emissions are highly uncertain since local and tribal governments do not keep detailed locations and activity levels. GIS data from the City of Albuquerque was consulted to estimate the miles of unpaved roads. As this is considered the best available dataset for locations and improvement can be made to update the many miles of unpaved roads in the agricultural areas and open range land.

Agricultural emissions would be improved by better quantifying local conditions and practices as well as soil silt levels. While alfalfa field tilling and harvesting emission factors were based on studies in the San Joaquin Valley of California, it is unknown if local agricultural practices are applicable to those in those studies. Unpaved roads on agricultural land would greatly benefit from local VMT rates specific to Bernalillo County.

As mentioned earlier, the on-road mobile source inventory used national default vehicle age distribution and VMT fractions. These two parameters may affect the emissions significantly, if the local values differ widely from national defaults. Based on initial data, it appears that the VMT fraction of HDDV on interstates might be underestimated when using the national defaults and thus the current inventory may be underestimating emissions from HDDV. However, further research is needed once local data is available. Future efforts must focus on developing an age distribution for the region. In addition, the VMT fraction on each functional classification (roadway type) must be evaluated and used instead of the national default values in the MOBILE6 model.

Fugitive dust from rock quarrying, sand and gravel operations and rock crushing also contribute to the overall inventory. Included in the permitting include certain processing equipment and operations such as crushing, screening, material handling, and storage piles. While some of the point source emissions captured these fugitive emissions as part of the NSR and Title V permitting programs, there are emissions from the rock crushing and gravel mining industry that are not inventoried. For example, inactive mined areas and haul roads may include areas with the potential to emit windblown particulates. Table 8.1-1 includes a list of quarries and sand and gravel pits as inventoried by the USGS. One such facility that fits into this category is the Grupo Cementos de Chihuahua (GCC) Portland cement plant located in the village of Tijeras. This facility mines approximately 600,000 tons per year of limestone on approximately 1,900 acres with 100 acres of active mining.

Table 8.1-1 Crushed stone and gravel pits in the county

Type	Company	Site Name	MSHA No.	Commodity
Crushed stone	Armenta Trucking	Tijeras	2901255	Shale & limestone
Crushed stone	Rio Grande Portland Cement/GCC of America	Tijeras	2900013	Limestone
Crushed stone	Isleta Cinder & Gravel Enterprises	Isleta Pits	2900906	Volcanic cinders
Crushed stone	Western Mobile NM, Inc.	Sedillo Hill	2901380	Limestone
Sand & gravel	Calmat Co. of NM	Shakespeare Pit	2900418	Gravel
Sand & gravel	Rays Sand & Gravel Co.	Vallejos Gravel Pit	2900444	Gravel
Sand & gravel	Western Mobile Inc.	Osuna Pits	2900499	Gravel
Sand & gravel	Perry Sales	Perry Sales	2901514	Gravel

For example, Figure 8-1 shows an aerial photo of the Shakespeare Pit in the North Valley. A closer look into the uninventoried emissions needs to be done for this area.

Figure 8-1 Shakespeare Pit as it was in 2004.

Figure 8-2 shows the state of the GCC Portland Cement plant in 2004. This facility covers a rather large area and an inventory of fugitive dust sources would require a detailed site survey and listing of active and inactive mining areas as well as truck traffic counts.

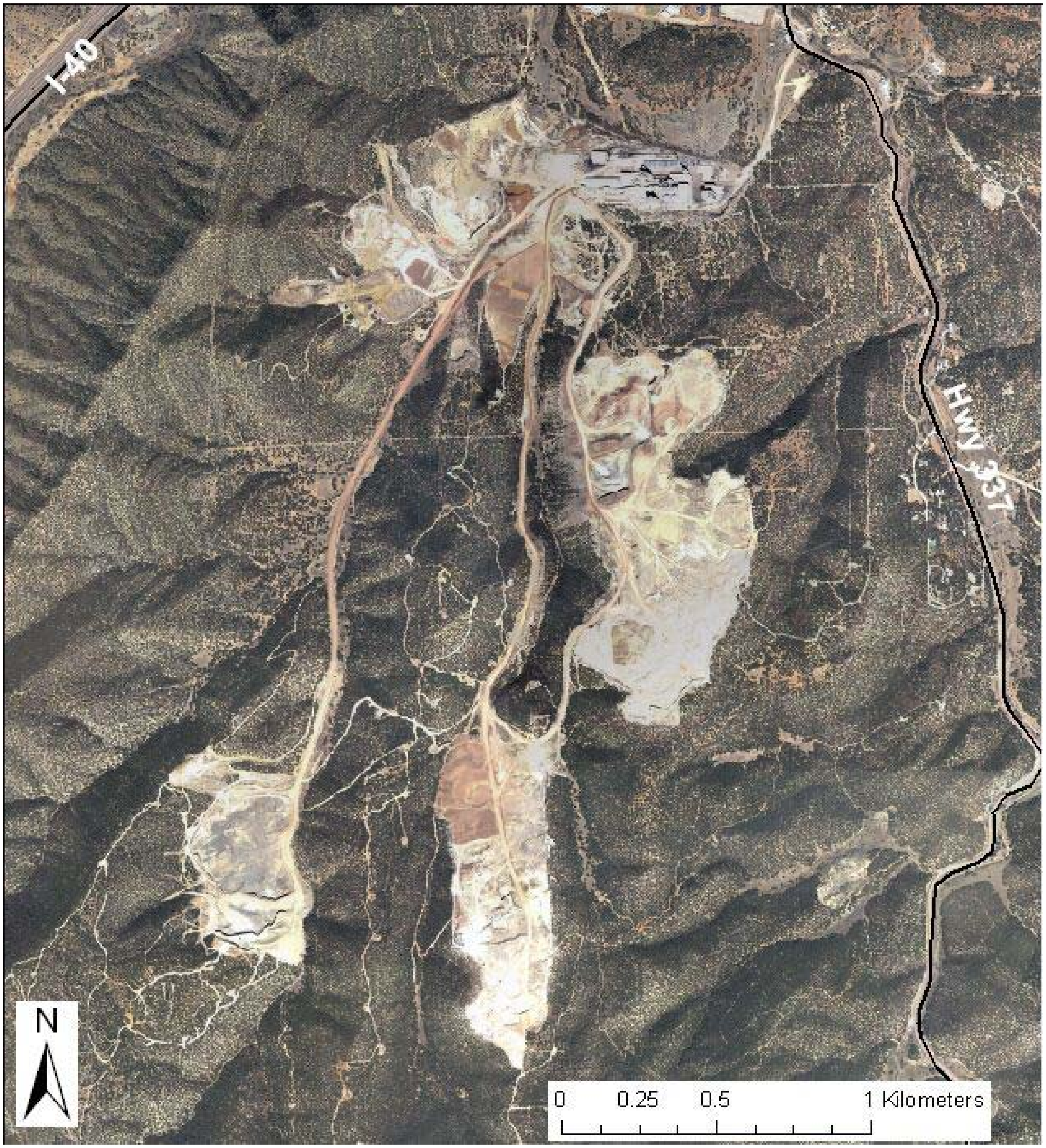


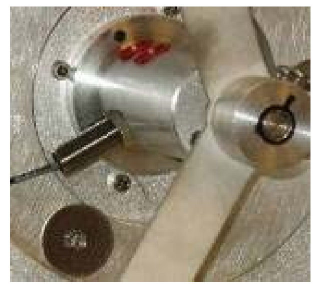
Figure 8-2 GCC Portland Cement mining area based on a 2004 aerial photo

8.1 PI-SWERL

The straight-line portable wind tunnel is currently the method that is closest to a "standard" instrument for direct measurement of PM_{10} dust emission fluxes from soils. For example, The University of Guelph's suction-type straight-line field wind tunnel is approximately 1 m × 1 m × 11 m long. The long test section of the wind tunnel is required, by scaling considerations for the correct simulation of the physics of the atmospheric boundary layer and the sand saltation process. Unlike large field wind tunnels, the Portable In-Situ Wind ERosion Laboratory (PI-SWERL, Figure 8-3) provides a measure of the stability of a soil by directly generating wind shear above the surface using a rotating annular ring. The advantage of the PI-SWERL is the relative speed with which measurements can be performed, with each test requiring less than fifteen minutes including setup. Side-by-side tests between the PI-SWERL and the University of Guelph straight-line field wind tunnel were conducted at 23 different sites in Southern California (Etyemezian et al., 2006a). Applying a simple empirical correction based on surface cover to the PI-SWERL data yielded the correspondence shown in Figure 8-4a. When the data from Figure 8-4a were averaged appropriately (over 0.2 decades in the case of the figure), the resultant relationship between wind tunnel and PI-SWERL measurements was quite strong (Figure 8-4b).

a. PI-SWERL in testing position

b. Inside the PI-SWERL

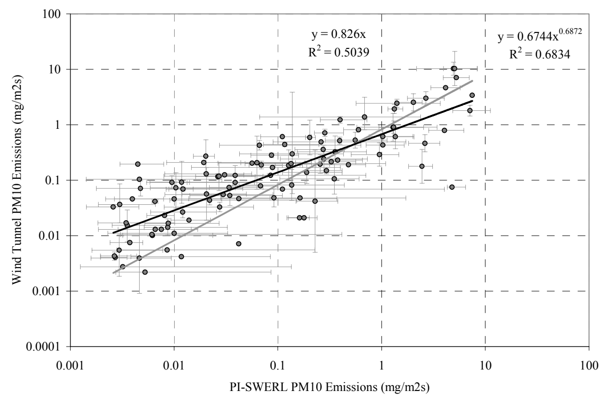


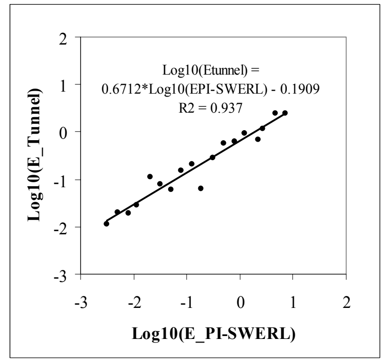
c. Shaft and RPM gauge

d. PI-SWERL on ATV

e. Mini PI-SWERL

Figure 8-3. Photographs of PI-SWERL





a. PM_{10} emissions from all sites at all levels of shear stress	b. same as a. but data averaged over intervals of 0.2 decades

Figure 8-4. Scatter plot of wind tunnel PM_{10} emissions versus PI-SWERL measured PM_{10} emissions from 23 collocated tests. An empirical correction has been applied to the PI-SWERL data to account for differences in the boundary layer depth from University of Guelph wind tunnel.

8.2 TRAKER

Inhalable dust emissions from paved and unpaved roads are frequently estimated by measuring airborne concentrations of PM_{10} upwind and downwind of a road (Cowherd et al., 1984; Gillies et al., 1999). Combined with measurements of wind speed and direction, the differences between the downwind and upwind concentrations can be used to estimate the horizontal flux of PM_{10} dust across the plane that is parallel to the road and perpendicular to the ground. The upwind/downwind technique is not practicable for measurement of emission factors on the scale of an entire airshed because of the costs involved. A more common practice is to measure a surrogate for emission factors. In the AP-42 guidance document (USEPA, 1999), the USEPA suggests the procurement of loose debris from roads by vacuuming and subsequently analyzing the vacuumed material for silt content. Silt, in this case, is defined operationally as the portion of material that passes through a 200 mesh sieve, corresponding roughly to particles having geometric diameters less than 75 microns.

Kuhns et al. (2001) and Etyemezian et al. (2003a) have described a vehicle-based alternative to silt measurements. The TRAKER (Testing Re-entrained Aerosol Kinetic Emissions from Roads) is a cargo van that measures road dust emission potential by utilizing three inlets, two that are behind each of the front tires and one that extends through the front bumper in front of the vehicle. As the TRAKER is driven on a road, air that is laden with particles suspended behind the front tires and background air sampled ahead of the front bumper are channeled to nephelometer-style instruments (TSI, DustTrak model 5820) located inside the vehicle. The instruments record PM_{10} concentrations in one-second intervals. An onboard GPS logs the location of each one-second measurement as well as other parameters such as the speed, acceleration, and heading of the TRAKER.

The great advantage of mobile road dust sampling systems such as the TRAKER is the speed and spatial and temporal resolution with which data can be acquired. Etyemezian et al. (2003b) assembled a PM_{10} paved and unpaved road emission inventory for the Treasure Valley, Idaho using several hundred of miles of roadway measurements during winter and summer in place of the customary dozen or two silt measurements at fixed locations traditionally used for the same purpose. The TRAKER also allows for determining which roadway parameters (e.g. location, traffic volume, posted speed limit, and proximity to other dust sources such as construction sites) have a measurable effect on emission factors with a high level of precision (Etyemezian et al., 2006b). The TRAKER has been used to measure paved and unpaved road dust emissions in Las Vegas, NV (Kuhns et al., 2001, Etyemezian et al., 2005), the Treasure Valley, ID (Etyemezian et al., 2003b), El Paso, TX (Gillies et al., 2005; Kuhns et al., 2005), and Lake Tahoe, NV (Kuhns et al., 2004).

Figure 8-5 Testing Re-entrained Aerosol Kinetic Emissions from Roads (TRAKER) van

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10. APPENDIX A: GROUND TRUTHING

Site visits were conducted on 8/2/2005, 11/22/2005, 2/16/2006 and 3/21/2006 to verify certain source areas, collect data on the size and activity and to reconcile differences between databases and actual conditions. Aerial, satellite and photos taken on the ground were used for this task. Figure A-1 indicates some of the locations where photos were taken to document potential sources of dust for this inventory.

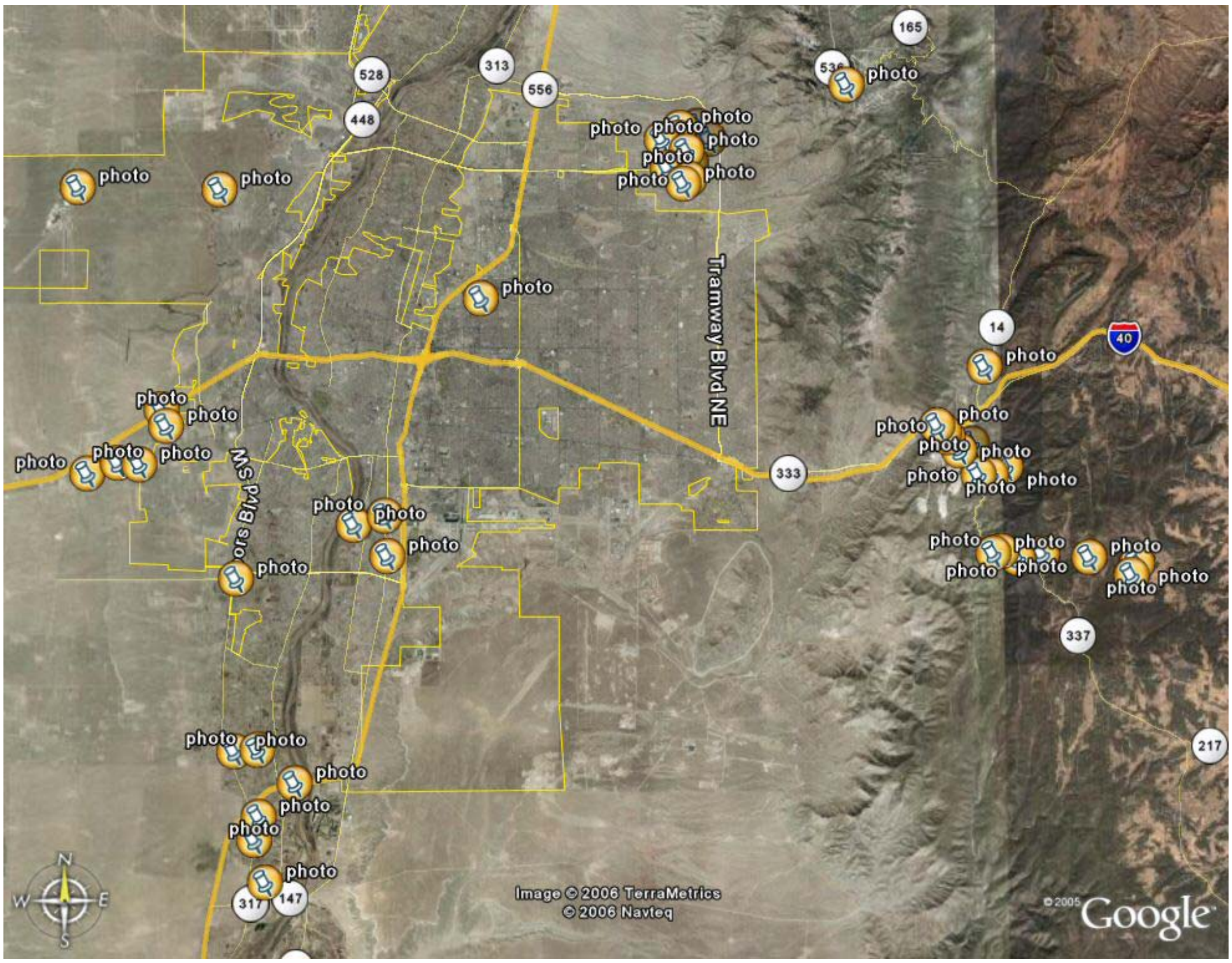

Figure A-1 Site survey points during this study. Aerial photo is courtesy of Google Earth and acquired at an unknown date.

Agricultural areas in Bernalillo County

Site visits to the southern portion of the county to verify agricultural practices and locations of farming for the inventory. Figure A-2 shows an area of mixed agriculture and residential in the South Valley taken in March 2006. The field on the west side of Coors has been tilled and left bare while the fields on the east side have been left with last season's alfalfa crop weathering the winter. At the bottom of the photo there are some lots of vacant land that have been disturbed at some point in time. Depending on the disturbance level, these could be sources of fugitive dust during high winds.

Figure A-2 Agricultural areas near the intersection of Rio Bravo and Coors Blvd WalMart's white roof can be seen at the center of the photo.

Figure A-3 shows alfalfa fields tilled and some left with a winter crop. This area is located just south of Rio Bravo Blvd on the east side of the Rio Grande. Notice the agricultural unpaved roads surrounding the fields. This inventory used surrogates of acres of alfalfa to determine emissions from unpaved roads rather than from miles of roads and ADT levels. Perhaps the next county PM_{10} inventory could refine this source type by determining the miles of roads and estimating traffic levels based on crop type and local practices.

Figure A-3 Agricultural fields on east side of Rio Grande near Rio Bravo Blvd. Notice that within the same general area some fields are tilled and some are left with last season's growth

Figure A-4 shows an agricultural area in the South Valley off of Coors Blvd on Isleta Pueblo land. This area indicates both tilled and untilled fields for alfalfa crops. The tilled field was plowed resulting in large clumps of soil. Most of the furrows run east to west or perpendicular to the road.

Figure A-4 South Valley agricultural area on Coors Blvd just south and east of I-25 (where I-25 crosses over to the west side of river). Aerial photograph is from the county's 2004 collection.

Figure A-5 shows the results of weed abatement by burning water channels. This photo was taken adjacent to the photo in Figure A-4 on Isleta Tribal land.

Figure A-5 Burning residue between fields off of Coors Blvd on east side of road

Figure A-6 is an agricultural area in the South Valley just north of Los Padillas Road between Isleta and Coors Blvd. This location indicated a good example of having a winter stubble crop left over from last season.

Figure A-6 South Valley agricultural area on Luchetti Road between Coors Blvd and Isleta Blvd. Aerial photograph is from the county's 2004 collection..

Figure A-7 shows a close-up of the winter alfalfa crop left over from last season. Using the agricultural practice will eliminate any fugitive dust emissions during the winter and spring high wind events.

Figure A-7 Detailed look at winter alfalfa stubble in a field on the north side of Luchetti Road at the same location as in Figure A-6.

Recreational Trails

To estimate emissions from recreational trails an estimate of the potential erodible area was determined from measurements of typical trails in the East Mountain area.

Figure A-8 Cibola National Forest, Tunnel Canyon trail off of Hwy 337 south of I-40. This is a typical high traffic and well-maintained trail on National Forest land.

Figure A-9 Cibola National Forest, Cedro Creek Trail south of I-40 off of Hwy 337. This is another typical well-maintained trail on National Forest land.

Figure A-10 Head of Coyote trail at the end of Chamisoso Road in the Cibola National Forest. This is a wide multiuse trail that allows hikers, bikes, horses and dirt bikes.

Figure A-11 Paseo del Nordeste recreation trail near intersection of Carlisle and Comanche Rd. This is an typical example of the network of paved bike trails that can be found throughout Albuquerque.

Unpaved Roads

Major unpaved roads that are accessible to the public were determined from a discussion with the Cibola District rangers. High use dirt roads are summarized in Table 4.8-5.

A high-use unpaved road is Juan Tomas Road in the East Mountains. Unlike the other roads, this road serves as access to many residents as well as a recreational road. While WRAP fugitive dust handbook recommends a vehicle speed of 50 mph for emission calculations, driving on this road at that speed is not typical because of the many hills, turns, loose gravel and blind curves. A more typical speed is in the range of 15 to 20 in the curves 25 to 35 mph on the straight sections. There are short sections of this road that are paved but most of it are unpaved.

Figure A-13 Unpaved section of Juan Tomas Road

Chamisoso Road is an example of a publically accessible recreational road in the East Mountain region. The southern portion of that road is open to any vehicle and used by autos, hikers, mountain bikers as well as horses. The northern portion of that road is closed to the public and gated at the Coyote Trail head. The Coyote Trail is indicated as the red line in Figure A-12.

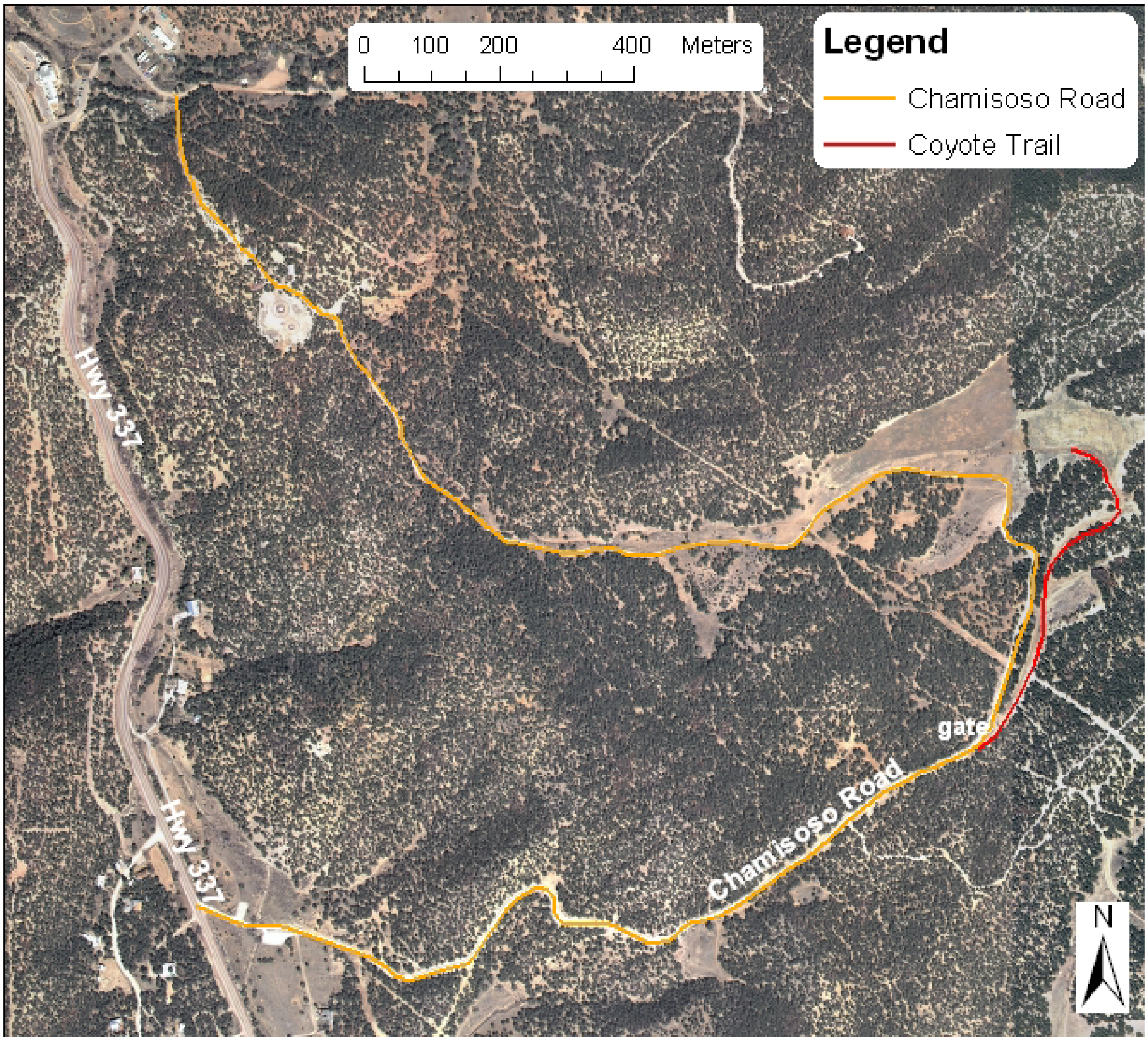

Figure A-12 Unpaved portions of Chamisoso Road east of Hwy 337, south of I-40 in Tijeras. Aerial photograph is from the county's 2004 collection.

Figure A-14 Unpaved Chamisoso Road in Cibola National Forest

Figure A-15 Unpaved road in Cibola National Forest. This is the end of the public use portion of Chamisoso Road.

There are portions of the Northeast Heights with unpaved roads that serve low density residential neighborhoods. Figure A-16 shows one these roads that run east-west north of Paseo del Norte.

Figure A-16 Unpaved road in NE Heights

Open Lots

Based on aerial and satellite images, there are many open lots and networks of recreational trails/roads clustered over the west mesa and northwest part of the Valley.

Figure A-17 Disturbed vacant land and sand dunes on west mesa. Major roads in the photo include I-40 (top) and Central Avenue (bottom). Notice the networks of recreational ATV trails throughout the area.

Figures A-18 and A-19 show examples of stages of new housing developments on the west side. Areas with disturbed lots such as this are likely good sources of wind-blown dust during high wind episodes.

Figure A-18 Construction area for future housing lots on the west mesa

Figure A-19 Aerial photo of new development in the west mesa

There are many open lots with areas of disturbed land such as in Figure A-20. Many lots are on private industrial land inaccessible to the public by fences.

Figure A-20 South Valley open lot along Isleta Blvd

Figure A-21 shows an example of a highly erodible unpaved parking lot in the NE Heights near the South Domingo Baca Dam for the equestrian and neighborhood park.

Figure A-21 Unpaved parking lot in NE Heights near Paseo del Norte

Parts of the industrial area in the South Valley are undeveloped with some level of vegetation covering the soil. The area shown in Figure A-21 is an example of that type of area north of Rio Bravo Blvd.

Figure A-21 Open lot in the South Valley near Rio Bravo and I-25