CRITTENDEN COUNTY STATE IMPLEMENTATION PLAN

EMISSION INVENTORY
FOR
VOC, NOX, AND CO

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Submitted To
U. S. Environmental Protection Agency

By
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I. INTRODUCTION

A. BACKGROUND

This document represents the 2002 8-Hour Ozone State Implementation Plan (SIP) emissions inventory for VOC, NO_x and CO, as required by the Clean Air Act Amendments (CAAA) of 1990. As does the original Clean Air Act of 1970, the CAAA of 1990 contains provisions for the attainment and maintenance of National Ambient Air Quality Standards (NAAQS) for criteria pollutants. The CAAA requires the revision of existing plans in states containing areas designated as nonattainment prior to 1990 and the development of new plans in newly designated nonattainment areas such as Crittenden County in Arkansas. The CAAA requirements are very specific, but vary in accordance with the severity of the particular area's air pollution problem. Section 182(a)(1) of the CAAA requires states with nonattainment areas to submit a comprehensive, accurate, current inventory of actual emissions of ozone precursors from all sources within two years of enactment. According to a memorandum dated November 18, 2002, Lydia N. Wegman, EPA Director of Air Quality Strategies and Standards Division, provided guidance for the nonattainment designations for the 8-hour ozone national ambient air quality standards. Her memorandum identifies 2002 as the base year for emission inventory SIP planning. Enclosed is our base year 2002 emission inventory for Crittenden County which was classified as "marginal" by the EPA. For ozone nonattainment areas, three precursor pollutants must be inventoried: volatile organic compounds (VOCs), oxides of nitrogen (NOx) and carbon monoxide (CO).

B. EMISSIONS SUMMARY

The agency directly responsible for the preparing and submitting the 2002 Ozone SIP Emissions Inventory was the Arkansas Department of Environmental Quality (ADEQ). ENVIRON was contracted to perform the work necessary to create the on-road, nonroad inventory and the nonpoint sources, and we accepted the EPA's biogenic source inventory. The emissions for VOC, NOx and CO are estimated in both annual tons per year (TPY) and daily tons per day (TPD) basis. Daily emissions are estimated for typical peak ozone season day. The peak ozone season is defined as that contiguous three-month period of the year during which the highest number of ozone exceedances have occurred over the past three years. During the review of the last four years, the months of June, July and August had the most exceedances in Arkansas. Therefore, the peak ozone season for the 2002 8-Hour Ozone SIP Emissions Inventory for VOC, NOx and CO is defined as June through August. Peak ozone daily emissions represent average emissions that occurred on a typical weekday during the peak ozone season. All references to daily or seasonal emissions in this document mean peak ozone season daily emissions.

In this inventory, VOC, NOx and CO emissions sources are categorized into point, nonpoint, nonroad, onroad and biogenic sources. Peak ozone season daily emissions are estimated for all of these categories. The nonpoint, nonroad and onroad sources were prepared by ENVIRON International Corporation and the Eastern Research (ERG) group for ADEQ. Environ's inventory and the ADEQ's point source emission inventory were combined and submitted to the EPA on June 1, 2004 with corrections submitted at the end of June 2004 and other revisions being submitted to the EPA prior to 5/01/05 that MACTEC Federal Programs made under a contract with ADEQ. MACTEC's review of our data made statewide reductions of VOC's by 38%, NOx by 8% and CO by 5%. We utilized the i-STEPS database developed by MACTEC and stored our emissions data in their licensed database. During the contract period, MACTEC restructured and renumbered our database and compared existing hard copy data for Crittenden County with the data in i-STEPS to ensure accuracy and completeness. We then used this data for our ozone nonattainment issues and for a baseline for future improvement.

The ENVIRON/ERG team used methods contained in the Arkansas Quality Assurance Project Plan (QAPP). In some cases, alternative methods, instead of preferred methods of inventory estimation, were used to complete the emissions estimates within the time frame allotted.

II. SECTION

A. NONPOINT SOURCE INVENTORY

The nonpoint source inventory included emitters of ozone pollutants (i.e., VOC, NOx and CO) such devices that combust fuel (e.g., wood stoves, commercial and industrial boilers), disperse industrial and commercial VOC sources (e.g., dry cleaners, degreasing and industrial surfaces coating), gasoline distribution, asphalt paving, and fires and open burning (e.g., agricultural burning, structural fires wildfires, prescribed burning).

For some source categories, the methodologies actually used in the Arkansas nonpoint source inventory are different than those originally proposed due to newly developed methodologies. Also, because some data were not available, alternate sources of data for some source categories were used. The industrial fuel combustion categories in the Arkansas nonpoint inventory were reconciled with industrial point source fuel data in order to prevent potential double counting of emissions. The industrial point source fuel data was obtained from ADEQ's Emission Inventory Questionnaire (EIQ) (ADEQ 2004). The 2002 EIQs were being processed and could not be used; The 2001 EIQ was used instead. All EIQ fuel use data was being processed and could not be used; The 2001 EIQ was used instead. All EIQ fuel use data was directly input "as is" into a spread sheet form the EIQ forms. The only adjustments made to the EIQ data were conversions units (i.e., natural gas to 10^6 ft^3, distillate and residual fuel oil to 10^3 gallons, and coal to tons) and corrections of obvious inconsistencies (e.g., wood combustion reported in units of 10^6 ft^3 for a natural gas boiler was switched to natural gas combustion, etc.). Facilities with ambiguous fuel types, quantities, or units were omitted from the reconciliation. The reconciliation was performed by subtracting state level EIQ industrial nonpoint fuel use from the nonpoint inventory's state level industrial combustion fuel use. Fuel use from utility facilities listed in the EIQ was not included in the EIQ fuel use totals. Distillate fuel oil, residual fuel oil, natural gas, and coal were included in the reconciliation. LPG use was not identified in the EIQ fuel use data. As a result of the reconciliation, state level industrial fuel use in the nonpoint inventory was adjusted (i.e., distillate fuel oil reduced by 4.3 percent, natural gas reduced by 45.0 percent and coal reduced by 16.8 percent). For residual fuel oil, the EIQ fuel use data exceeded the industrial fuel combustion nonpoint fuel use estimate. Therefore, industrial fuel combustion or residual fuel oil in the nonpoint inventory was adjusted to zero. Reconciliation for other area source categories (i.e., industrial surface coating or degreasing) was not preformed because data was unavailable on the EIQ forms.

III. SECTION

A. ONROAD SOURCE INVENTORY

The onroad mobile source emissions included emissions from vehicles certified for highway use – cars, trucks, and motorcycles. Emissions from these sources were estimated by combining EPA emission factors from the MOBILE6 model, expressed in grams per mile (g/mile), with vehicle miles traveled (VMT) activity data. For all of the Arkansas counties, county-level Highway Performance Monitoring System (HPMS) VMT data was used. The data collected as part of the onroad inventory were reviewed prior to use in emission calculations. All modeling inputs, data processing and calculation spreadsheets were checked by a technical supervisor. Annual average daily HPMS VMT data were provided by the Arkansas Highway and Transportation Department (AHTD). This data was reported separately for urban and rural areas and within those categories, by county and HPMS facility class. The AHTD provided data for 2007 and 2010 and these were exponentially extrapolated back to 2002. To arrive at month-specific estimates, the annual average was adjusted using seasonal factors derived based upon data provided by AHTD. Finally, to obtain weekday VMT (for the summer and winter reporting requirements) the monthly values were corrected using Texas statewide average weekday/annual average daily factors: there were no default factors from EPA, and these were considered to be the best, given the limited data available from only a few states. For each county, MOBILE6 emission was used in combination with the VMT data to estimate emissions by roadway type and vehicle type and vehicle class. National average speeds derived from HMPS data for each facility class were utilized. Monthly emissions were first estimated from which annual total, summer weekday, and winter weekday emissions were derived.

IV. SECTION

A. NONROAD EMISSION INVENTORY

Nonroad mobile sources encompass a wide variety of equipment types that either move under their own power or are capable of being moved from site-to-site. More specifically, these sources, which are not licensed or certified as highway vehicles, are defined as those that move or are moved within a 12-month period and are convered under the EPA's emissions regulations as nonroad mobile sources. Where feasible and appropriate, local activity data for specific source categories were gathered and used to develop the inventory.

US EPA's draft NONROAD2002 model (June 2003 version) was used to estimate emissions for most nonroad sources. The NONROAD model estimates emissions from non-road equipment in the following categories:

- Agricultural equipment, such as tractors, combines and balers
- Airport ground support, such as terminal tractors
- Construction equipment, such as graders and back hoes
- Industrial and commercial equipment, such as fork lifts and sweepers
- Residential and commercial lawn and garden equipment, such as leaf and snow blowers
- Logging equipment, such as shredders and large chain saws
- Recreational equipment, such as off-road motorbikes and snowmobiles and
- Recreational marine vessels, such as power boats

Aircraft, commercial marine, and locomotive emissions were also included in the non-road inventory, but these sources were estimated separately since they were not included in the NONROAD model. General EPA methodologies were followed to estimate emissions for these three categories. For all source categories, annual average emissions have been estimated in tons per year, and ozone season and winter season daily emissions are estimated in tons per day. All data collected as part of nonroad sources, emission inventory were thoroughly reviewed to ensure that they were the most appropriate and up-to-date emission factors available.

V. SECTION

A. POINT SOURCE INVENTORY

ADEQ is responsible for compiling the point source inventory. The Air Division Emission Inventories and Data Management Section is accountable for identifying point sources meeting the threshold criteria, collecting facility emissions data, processing, managing data, compilation and displaying the results. Emissions data provided by the facilities are estimates of actual emissions for the facility during the previous year. Estimation methodologies are required to follow state and federal guidelines. Point Sources are large, stationary, emissions sources that release pollutants into the atmosphere. According to the Consolidated Emissions Reporting Rule (CERR), states are required to report data for large point sources, or Type A point sources, on an annual basis, starting with the 2001 inventory. Type B sources refer to all point sources, including Type A sources. The reporting frequency for Type B sources has been established as once every 3 years, starting with the 2002 base year inventory.

Actual measurement with continuous emissions monitoring systems (CEMS) is the desired method of calculating emissions from a point source. In lieu of CEMS data, emissions may be calculated using other stack test data, material balance, or emissions factors from AP-42 or approved engineering journals. Since the data is used for modeling and other purposes, data elements include parameters and coordinates, control devices and efficiencies, actual emissions, emission factors, process codes and parameters. All data is processed into the i-STEPS database which automatically applies minimum quality assurance and quality control checks. Further, the data is processed for inaccuracies and that which cannot be readily resolved is referred back to the facility for clarification/correction.

In addition, the reporting requirements for the nonattainment area are in accordance with those of the CAAA of 1990, and we are revising Regulation 19 to require the owner or operator of each stationary source to submit annual emissions statements of emissions of nitrogen oxides and volatile organic compounds which will satisfy the requirements of the Clean Air Act §182(a)(3)(B). The statement will contain a certification that the information contained in the statement is true and accurate to the best knowledge of the certifying official.

Table 1. Summary of 2000 Demographic Information for Crittenden County, Arkansas

Demographic Parameter	Value
Population	50,866
Land Area (square miles)	637
Number of Housing Units	18,471
Manufacturing Employment	2,911
Construction Employment	1,456
Retail Employment	2,431
Poverty (% of Individuals)	25.3
Gasoline RVP	9.0

Table 2. Crittenden County - Arkansas 2002 Emission Inventory

Pollutant Emissions (TPY)		
VOC	NOX	CO
11,366	7,566	39,137

Table 3. Crittenden County - Arkansas 2002 Emission Inventory

Pollutant Emissions (TPD)		
VOC	NOX	CO
57.29	23.49	150.91

Table 4. Annual and Peak Ozone Season Daily Emissions by Source Category
Crittenden County - Arkansas 2002 Emission Inventory

Source Category	Pollutant Emissions					
	VOC		NOX		CO	
	Annual (TPY)	Daily (TPD)	Annual (TPY)	Daily (TPD)	Annual (TPY)	Daily (TPD)
Point Sources*	578	2.21	273	1.05	92	0.35
Stationary Nonpoint Sources**	1,390	7.66	204	0.84	7,152	61.34
Nonroad Mobile Sources**	891	2.71	3,753	11.99	5,377	18.02
On-Road Mobile Sources**	1,832	5.13	2,834	7.61	25,294	64.57
Biogenic Sources***	6,675	39.58	502.2	2.00	1,222	6.63
County Total	11,366	57.29	7,566	23.49	39,137	150.91

*Daily values for Point Sources calculated for industrial work days (261 days/year)
**Daily values calculated from Environ work project
***Values provided by EPA

Figure 1. 2002 VOC Annual Emissions for Crittenden County

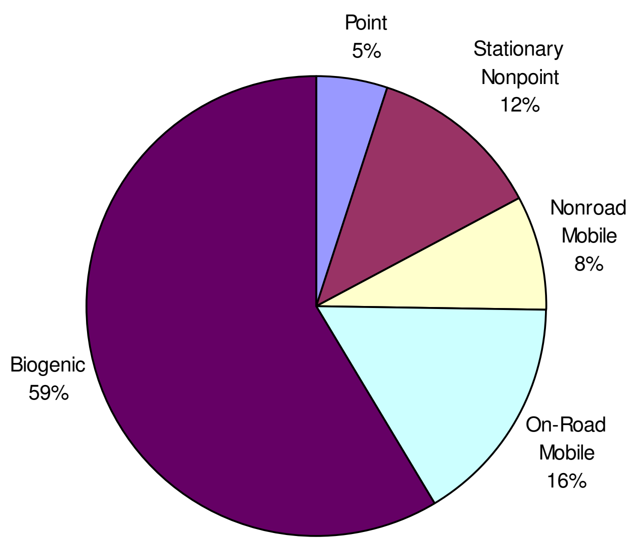


Figure 2. 2002 NO_x Annual Emissions for Crittenden County

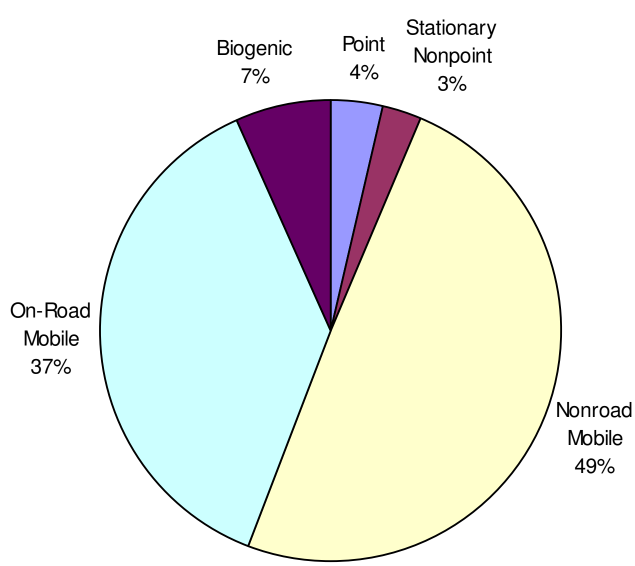
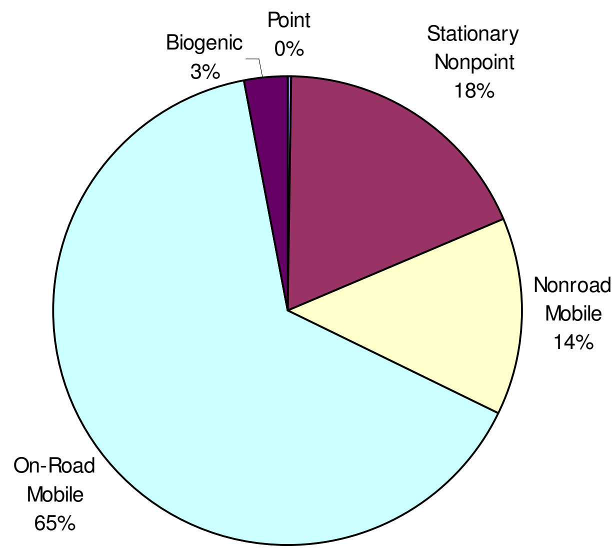
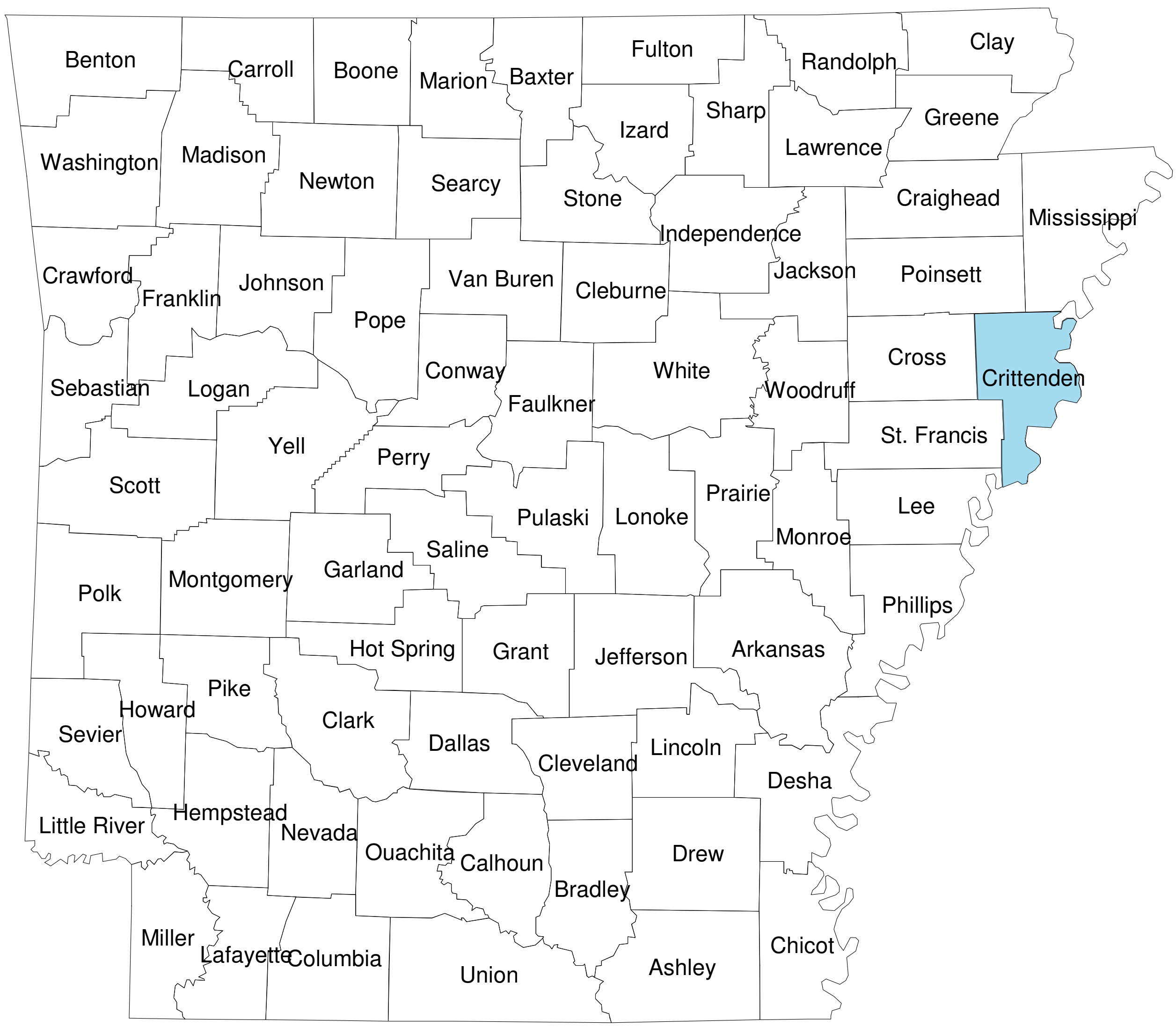


Figure 3. 2002 CO Annual Emissions for Crittenden County



APPENDIX A

Arkansas Designated 8-Hour Standard Ozone Non-Attainment Area



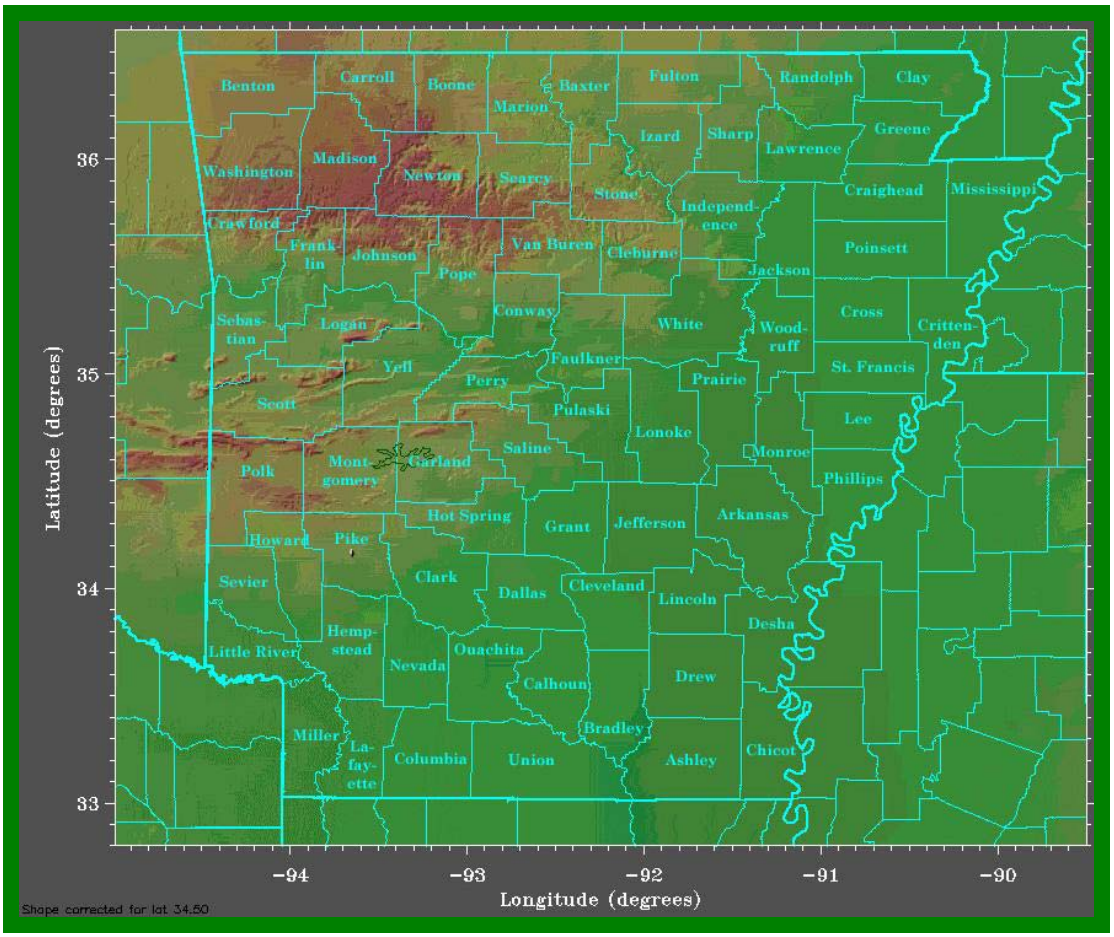
Designated non-attainment area

APPENDIX B

ENVIRON

International Corporation | *Air Sciences*

Final Report
Arkansas 2002 Emission Inventory



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1. INTRODUCTION

The calendar year 2002 emission inventories described in this document were prepared by ENVIRON International Corporation and the Eastern Research Group for the Arkansas Department of Environmental Quality (ADEQ). This emission inventory will be combined with ADEQ's point source emission inventory and submitted to EPA as required by the Consolidated Emissions Reporting Rule (CERR), promulgated in June 2002. This section first describes the CERR requirements, and then provides the scope of the emission inventory work performed.

CONSOLIDATED EMISSIONS REPORTING RULE (CERR) REQUIREMENTS

Under the provisions of the final promulgated CERR (67 FR No. 111, 39602), states are required to submit certain emission inventory data to U.S. EPA by June 1, 2004. The base year for the emissions data to be reported in June 2004 is 2002. For area, onroad mobile, and nonroad mobile sources, the following pollutants must be included, as applicable and required for CERR submittal for a 2002 base year:

- Sulfur oxides (SO_x);
- Volatile organic compounds (VOC);
- Nitrogen oxides (NO_x);
- Carbon monoxide (CO);
- Lead (Pb) and lead compounds;
- Primary particulate matter (PM_{10}, $PM_{2.5}$); and
- Ammonia (NH_3).

Emission estimates for area and mobile sources must be submitted for the entire state of Arkansas on a county level basis, regardless of the National Ambient Air Quality Standards (NAAQS) attainment status. Area sources are defined and inventoried according to the pollutant-specific reporting thresholds contained in the final CERR. These thresholds are 100 tons/year (tpy) of NO_x, SO_x, VOC, PM_{10}, $PM_{2.5}$, NH_3; 1,000 tpy of CO; and 5 tpy of Pb.

Although the CERR does not require the use of any specific emission estimation technique, for this project the ENVIRON/ERG team primarily used the methods contained in the Arkansas Quality Assurance Project Plan (QAPP). In some cases, alternative methods instead of preferred methods of inventory estimation were used in order to be able to complete the emissions estimates within the timeframe allotted.

The data elements to be reported for the 2002 inventory for area and onroad mobile sources (22 elements), and nonroad mobile sources (12 elements) are specifically defined in the CERR. These data fields for the appropriate category/pollutant combinations as listed in Table 1-1 are being provided in electronic data files to ADEQ in EPA's NIF3.0 format along with this report.

Table 1-1. CERR required data elements for area, nonroad mobile, and onroad mobile sources.

Required Data Element	Source Type		
	Area	Nonroad Mobile	Onroad Mobile
Inventory Year	●	●	●
Inventory Start Date	●	●	●
Inventory End Date	●	●	●
Inventory Type	●	●	●
State FIPS Code	●	●	●
County FIPS Code	●	●	●
SCC or PCC	●	●	●
Emission Factor	●	●	●
Annual Activity/Throughput Level	●	●	
VMT Activity by Roadway Class			●
Total Capture/Control Efficiency (%)	●	●	
Rule Effectiveness (%)	●	●	
Rule Penetration (%)	●	●	
Pollutant Code	●	●	●
Summer/Winter Work Weekday Emissions	●	●	●
Annual Emissions	●	●	●
Winter Throughput (%)	●	●	
Spring Throughput (%)	●	●	
Summer Throughput (%)	●	●	
Fall Throughput (%)	●	●	
Hours/Day in Operation	●	●	
Days/Week in Operation	●	●	
Weeks/Year in Operation	●	●	

FIPS = Federal Information Processing System
SCC = Source classification code
PCC = Process classification code
VMT = vehicle miles Traveled

EMISSIONS INVENTORY SCOPE

The scope of the Arkansas area, on-road and off-road mobile sources emissions inventory documented in this report is as follows:

- **Source Categories:** Emissions in this report are presented for area sources (e.g., solvent usage, open burning, fugitive dust), on-road mobile sources (e.g., cars and trucks), and off-road mobile sources (e.g., lawn and garden equipment, agricultural equipment, aircraft). The CERR 2002 point source emissions files are being prepared by ADEQ.

- **Pollutants:** The pollutants included in this analysis are the ozone precursors and additional visibility-related pollutants. The ozone precursors are volatile organic compounds (VOC), nitrogen oxides (NOx), and carbon monoxide (CO). The additional visibility-related pollutants are PM_{10}, $PM_{2.5}$, sulfur oxides (SOx), and ammonia (NH_3). As required by CERR, lead (Pb) emissions are also included.

- **Temporal Resolution:** Emissions for calendar year 2002 have been estimated on an annual total basis. As required by the CERR, average summer work weekday and average winter work weekday emissions have also been estimated for all area, on-road, and off-road source categories. Seasons are defined as three-month periods: Summer is June through August, and Winter is January/February/December of the same year (i.e., not contiguous months). Also following the CERR, ozone season daily emissions are the same as summer work weekday emissions.

- **Geographical Domain:** Emissions by source category are provided for each of the 75 counties in the State of Arkansas, and the State total. The summer weekday an winter weekday emissions were gridded at a resolution of 4 km; gridded emissions displays are provided.

2. AREA SOURCE EMISSIONS METHODOLOGY

This section describes the methods, data, and assumptions used to estimate emissions for area sources located in the state of Arkansas.

The area source inventory includes emitters of ozone pollutants (i.e., VOC, NO_x, and CO) such as devices that combust fuel (e.g., wood stoves, commercial and industrial boilers), disperse industrial and commercial VOC sources (e.g., dry cleaners, degreasing, and industrial surface coating), gasoline distribution, asphalt paving, and fires and open burning (e.g., agricultural burning, structural fires, wildfires, prescribed burning). In addition, area source categories contributing visibility pollutants (i.e., primary PM_{10}, $PM_{2.5}$, and NH_3) are also included in the area source emissions inventory (e.g., fugitive dust, agricultural operations, livestock ammonia, etc.).

Emissions were estimated for all of the area source categories shown in Table 3-2 of the ENVIRON/ERG Technical Proposal (November 18, 2003). For some source categories, the methodologies actually used in the Arkansas area source inventory are different than those originally proposed in the Technical Proposal due to newly developed methodologies. Also, because some data were not available, alternative sources of data for some source categories were used. In all cases, the actual methodologies and activity data used to estimate annual and seasonal emission estimates for the Arkansas area source inventory are clearly presented below, as well as in the supporting calculation spreadsheets.

The industrial fuel combustion categories in the Arkansas area source inventory were reconciled with industrial point source fuel use data in order to prevent potential double-counting of emissions. The industrial point source fuel data were obtained from ADEQ's Emission Inventory Questionnaires (EIQs) (ADEQ, 2004). The 2002 EIQs are currently being processed and could not be used; the 2001 EIQs were used instead. All EIQ fuel use data were directly input "as is" into a spreadsheet from the EIQ forms. The only adjustments made to the EIQ data were conversions to consistent units (i.e., natural gas to 10^6 ft^3, distillate and residual fuel oil to 10^3 gallons, and coal to tons) and corrections of obvious inconsistencies (e.g., wood combustion reported in units of 10^6 ft^3 for a natural gas boiler was switched to natural gas combustion, etc.). Facilities with ambiguous fuel types, quantities, or units were omitted from the reconciliation. The reconciliation was performed by subtracting state-level EIQ industrial point source fuel use from the area source inventory's state-level industrial combustion fuel use. Fuel use from utility facilities listed in the EIQ was not included in the EIQ fuel use totals. Distillate fuel oil, residual fuel oil, natural gas, and coal were included in the reconciliation; LPG use was not identified in the EIQ fuel use data. As a result of the reconciliation, state-level industrial fuel use in the area source inventory was adjusted (i.e., distillate fuel oil reduced by 4.3 percent, natural gas reduced by 45.0 percent, and coal reduced by 16.8 percent). For residual fuel oil, the EIQ fuel use data exceeded the industrial fuel combustion area source fuel use estimate. Therefore, industrial fuel combustion of residual fuel oil in the area source inventory was adjusted to zero. Reconciliation for other area source categories (i.e., industrial surface coating or degreasing) was not performed because data were unavailable on the EIQ forms.

The data collection and emissions inventory development methodologies described below were conducted in accordance with ADEQ's Quality Assurance Project Plan (QAPP), as well as the requirements of the Consolidated Emissions Reporting Rule. All data collected as part of the area sources inventory were thoroughly reviewed prior to use in emission calculations. In addition, all emission factors used in the inventory were reviewed to ensure that they were the most appropriate and up-to-date emission factors available. Finally, all equations used for emissions estimation were checked for calculational accuracy; equations used multiple times in spreadsheets were checked for proper replication.

RESIDENTIAL WOOD COMBUSTION

Annual Emissions

The residential wood combustion (RWC) area source category includes both fireplaces and woodstoves. Ideally, an RWC survey would provide local activity data (e.g., quantity of wood burned by household, devices used, etc.) to quantify emissions. Previously it was determined that an RWC survey has never been conducted for the Little Rock metropolitan area (McCorkle, 2002). In addition, it does not appear that an RWC survey has ever been conducted for any other counties in Arkansas.

In lieu of a local survey, a recently developed national RWC emissions inventory disaggregated to the county level was used (Moulis, 2004a). This inventory was prepared in support of U.S. EPA's National Emissions Inventory (NEI) and coincides with the Arkansas inventory year of 2002. The national 2002 RWC inventory included seven different types of devices: fireplaces, fireplaces with inserts (EPA certified catalytic, EPA certified non-catalytic, and non-EPA certified), and woodstoves (conventional, catalytic, and non-catalytic). These device types were aggregated into two general categories: fireplaces and woodstoves. The county-level estimates from the national 2002 RWC inventory were incorporated into the Arkansas area source inventory without changes or adjustments.

Seasonal Emissions

Because RWC is primarily used for space heating, the RWC emissions were temporally allocated based upon heating degree days (HDD). An average monthly HDD profile for Arkansas indicates that 2,070 HDDs out of the annual total of 3,172 HDDs occur during the winter (i.e., December through February) and that no HDDs occur during the summer (i.e., June, July, August) (NCDC, 2004). Winter residential wood combustion emissions were calculated by multiplying annual emissions by the ratio of winter HDDs over total HDDs (i.e., 2070/3172 or 0.6526). Average summer and winter weekday emissions were then calculated by dividing the seasonal emissions by the number of days in that season (i.e., 90).

OTHER STATIONARY SOURCE FUEL COMBUSTION

Annual Emissions

The other stationary source fuel combustion category includes all industrial, commercial/ institutional, and residential fuel combustion (except for RWC). The fuel types include natural gas, propane/liquid petroleum gas (LPG), fuel oil (i.e., distillate, residual, and kerosene), and coal.

Ideally, a fuel survey of local fuel dealers would provide local fuel consumption data. However, resources to conduct a fuel survey for the entire state were not available. In lieu of a local fuel survey, state-level fuel consumption data were obtained from State Energy Data Report published by the Energy Information Administration (EIA, 2004a). The most recent State Energy Data Report is for 2000; the state-level fuel consumption data from that report were used in the Arkansas area source inventory.

The 2000 state-level energy data were disaggregated to the county-level as described in the EIIP area source method abstracts (EIIP, 1999a; EIIP, 1999b; EIIP, 1999c):

- Residential fuel use was disaggregated to the county level based upon the number of households heating with a particular fuel and the number of HDD. Household heating information was obtained from the 2000 census (U.S. Census, 2000a). County-level heating degree day information was obtained from the national 2002 RWC inventory described in the residential wood combustion section (Moulis, 2004a).

- Commercial and institutional fuel use was disaggregated to the county level based upon the number of employees for Standard Industrial Classifications (SICs) 50-99 (now National American Industry Classification System [NAICS] 42, 44, 51-56, 61-62, 71-72, 81, 95, and 99) (U.S. Census, 2001) and number of HDD (Moulis, 2004a).

- Industrial fuel use was disaggregated to the county-level based upon the number of employees for SICs 20-39 and 49 (now NAICS 22 and 31) (U.S. Census, 2001). As described at the beginning of the area source inventory section, the industrial fuel combustion area source categories were reconciled with point source fuel combustion using data obtained from the EIQ forms.

Emission factors for natural gas, propane/LPG, fuel oil, and coal were obtained from AP-42, (Sections 1.4, 1.3, 1.5, and 1.1, respectively) (EPA, 1995) and the Factor Information Retrieval (FIRE) Data System (EPA, 2000).

Emissions for the other stationary source fuel combustion source category were calculated using the following equation:

$$E_{f,p} = U_f \times EF_{f,p} \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right)$$

where $E_{f,p}$ = Emissions for fuel f and pollutant p (tons/year);
U_f = Fuel usage for fuel f (10^6 ft^3, 10^3 gal or ton); and

$EF_{f,p}$ = Emission factor for fuel f and pollutant p (lb/10^6 ft^3, lb/10^3 gal, or lb/ton).

A sample calculation using this equation for estimating VOC emissions for Pulaski County residential natural gas usage is as follows:

where U_{ng} = 7,776 MMscf (i.e., 10^6 ft^3);
$EF_{ng,VOC}$ = 5.5 lbs VOC/MMscf; and
$E_{ng,VOC}$ = 21.4 tons VOC/year.

Seasonal Emissions

Fuel use in the industrial sector is mainly related to industrial processes. It was assumed that the industrial sector operates year-round on a 5-day workweek schedule. It was also assumed that the industrial fuel combustion activity is relatively uniform throughout the year. The average summer and winter weekday emissions were calculated by dividing annual emissions by the total number of annual weekdays (i.e., 261).

Fuel use in the commercial/institutional and residential sector is divided into four main components: space heating, water heating, cooking, and other. Fuel use among these components was disaggregated by commercial/institutional and residential fuel consumption surveys conducted by the Energy Information Administration (EIA) (EIA, 2004b; EIA, 2004c).

Fuel combustion for space heating was allocated to seasons based upon HDD in the same manner as was used for RWC (described above). The other three components (i.e., water heating, cooking, and other) were assumed to be constant throughout the year. Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days. The average summer and winter weekday emissions for all four components were then summed together.

FUGITIVE ROAD DUST

Reentrained road dust emissions were estimated as the product of vehicle miles traveled (VMT) and an emission factor. Paved and unpaved roads were handled separately. Unpaved VMT were first estimated for 1996 and then projected to 2002 levels using growth factors developed as part of previous work for the Western Regional Air Partnership (WRAP). Statewide emissions were obtained first and subsequently allocated to the individual counties in the state also using WRAP allocation factors.

Unpaved road VMT is estimated as the product of the road mileage and the assumed average daily traffic volume (ADTV). The 1996 Federal Highway Administration's Highway Statistics Report (FHWA, 1996) was the source for the mileage estimate used in the current inventory. Data were reported separately for urban and rural roads.

The ADTV estimates for urban unpaved roads were based upon those in the Clark County, NV June 2001 PM_{10} SIP (available at http://www.co.clark.nv.us/Comprehensive_planning/Environmental/AirQuality/PM10SIP.htm). VMT estimates on urban unpaved roads were estimated using the average ADTV value for Clark

County (69.2), with adjustments for differences in population density. Urban unpaved road ADTV values for all counties were first estimated using the average Clark County ADTV and adjusting with the ratio of county population densities. Population densities were based upon 1990 U.S. Census Bureau population and land area data. The final ADTV was obtained by computing the arithmetic average of all the counties' volumes.

Roads managed by the National Forest Service constitute approximately one fourth of the total unpaved road mileage (10,013 miles out of 44,559 miles) in Arkansas. Given this information, it seemed prudent that rural volume estimates should specifically take into account the activity under this agency's jurisdiction; i.e. activity in national forests. The counties that have rural unpaved roads were first categorized into those with National Forests and those without. For the latter group, the Clark County-derived ADTV described above was assumed.

For the counties with NFS land (forests), the approach was based upon a methodology outlined by a NFS contact. Briefly, his approach is to spread a percentage of the annual number of forest visits upon a certain fraction of the NFS roads and over a certain portion of the year. This recommendation is consistent with the fact that 80 percent of their traffic occurs on about 15 percent of their roads. While this approach yields accurate local estimates, an enormous amount of geospatial data is required for its application. In order to be able to apply this approach within the available time and budget resources, the visits were spread over all NFS roads and over the entire year at the state level. The first part of the approach is in recognition that the NFS portion in the FHWA estimates does not distinguish those that have high and low activity level. The second portion is because seasonal allocation of VMT will take place in steps subsequent to this analysis.

For this approach, state level forest visitation (1996) data were obtained from the NFS web site (http://www.fs.fed.us/recreation/recinfo/recuse_93-96.shtml). County level unpaved road mileages were obtained from NFS staff. The average number of occupants per vehicle was estimated from surveys performed at various forests by the NFS (http://www.fs.fed.us/recreation/recuse/recuse.shtml). This number was used to convert the number of visitors to the number of vehicles. The result was then divided by the NFS unpaved mileage and by 365 to obtain the ADTV. The ADTV was multiplied by a factor of two according to the assumption that people will drive through the same roads twice to get in and out of the forest. These state average NFS ADTV were applied only to counties with National Forests (i.e., have NFS unpaved road mileage). Once the NFS estimates were obtained for each county, they were used in conjunction with the Clark County-based volumes as follows. The average of the NFS and Clark County-based ADTV were assumed for counties with National Forests, while the Clark County values alone were applied to counties without National Forests. Finally, these county-level ADTVs were combined to obtain an average value for the state using rural population as weighting factors. The resulting urban and rural state average ADTVs for Arkansas are 32 and 39, respectively.

Paved road VMT was estimated by subtracting the 2002 unpaved portion from the total, which was based upon data provided by Arkansas Highway and Transportation Department (AHDT). As mentioned above, both paved and unpaved road state-level VMT estimates were allocated to the individual counties using data from previous work for the WRAP. The summer and winter seasonal weekday estimates were estimated using AHDT seasonal adjustment factors in combination with the weekday/weekend adjustments. Both of these are discussed in more detail in the on-road section.

Emission factors for both road types were based upon the latest AP-42 guidance (available at http://www.epa.gov/ttn/chief/ap42/ch13/). Paved road fugitive dust emission rates were estimated for each facility class and season using state average silt loading and monthly urban area precipitation data. Unpaved emission factors were derived assuming a silt content of 3.9% and monthly rural area precipitation data. PM2.5 emissions were assumed to be 25% and 15% of PM10 emissions for paved and unpaved roads, respectively.

FUGITIVE DUST – CONSTRUCTION ACTIVITIES

Annual Emissions

Residential construction activities were estimated using single- and multi-unit housing permit data for some communities located in Arkansas (U.S. Census, 2004). The number of housing permits at the county-level was extrapolated based upon the populations of the counties and the communities with reported permit data (U.S. Census, 2000a).

A typical lot size of 8,500 ft^2 was previously identified for housing permits up to 4 units (Hoffpauer, 2002). A lot size of 2 acres was assumed for housing permits for 5 units and greater.

The PM_{10} fugitive construction dust emission factor was obtained from the best available control measure (BACM) document (MRI, 1996). A $PM_{2.5}$ size fraction was applied to the PM_{10} emission estimates in order to develop $PM_{2.5}$ emissions (ARB, 2002). It was assumed that the duration of construction that represents the level of activity characterized by the MRI emission factor was one month.

Emissions from construction activities were calculated using the following equation:

$$E = EF \times (A \times D)$$

Where E = PM_{10} emissions (tons/year);
EF = Emission factor (tons PM_{10}/acre-month);
A = Total area of residential construction for year (acres); and
D = Average duration of residential construction (months).

A sample calculation using this equation for estimating PM_{10} emissions for construction activities in Pulaski County is as follows:

Where EF = 0.42 tons PM_{10}/month-acre;
A = 361.82 acres;
D = 1 month;
E = 152.1 tons PM_{10}/year.

Seasonal Emissions

Construction activity was assumed to be constant throughout the year. Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

WINDBLOWN FUGITIVE DUST

The windblown fugitive dust PM emission inventory for the State of Arkansas was developed using the estimation methodology developed for the Western Regional Air Partnership (WRAP) by a team of contractors led by ENVIRON (ENVIRON, 2004). The methodology is based on the results of wind tunnel studies and a detailed characterization of vacant lands. Windblown dust emissions are estimated hourly on a gridded modeling domain using hourly averaged wind speeds and other meteorological parameters. Estimates are developed for every hour of the year 2002, and subsequently aggregated by county and summed across all hours to provide annual emissions estimates. Typical summer and winter day dust emissions are obtained by summing across the appropriate months (December, January, February for winter; June, July, August for summer) and dividing by the total number of days for each (92 for winter; 90 for summer)

The characterization of vacant lands is based on landuse/landcover (LULC), soil texture and the potential to emit fugitive dust. Vacant land disturbance potential is based on the assumed stability of the vacant land parcel as determined by the dominant LULC type within each grid cell. The total amount of erodible soil available for suspension through wind erosion is limited by the reservoir characteristics of the land parcel. A reservoir determination methodology was proposed for the WRAP Project and adopted for this study. Vegetation density, or canopy cover, will reduce the dust emission flux from that of a non-vegetative surface. Adjustments for vegetative cover are based on LULC classifications. Non-climatic effects are included to adjust emission from agricultural lands.

Wind Tunnel Studies

Field and wind tunnel experiments suggest that the emissions are proportional to wind friction speed and approximate theoretical model predictions, but the considerable scatter in the available data make it impossible to clearly define this dependence (Nickling and Gillies, 1993). Different surfaces appear to have different constants of proportionality for the flux versus wind friction velocity relationship, implying that the flux is predictable, but surface and soil properties affect the magnitude of the flux. A detailed discussion of wind tunnel studies, including various limitations and measured data, is provided in ENVIRON, 2003a; 2003b. The findings of the various wind tunnel studies are briefly summarized here.

Recently Alfaro *et al*. (2003) re-analyzed the Nickling and Gillies (1989) data and found that the tendency of a surface to emit dust depends not primarily on its textural qualities, but on the size distribution of the loose soil aggregates available for saltation, and the aerodynamic roughness length that conditions the emission threshold. The re-analysis was based in part on the work of Chatenet *et al*. (1996) in which they found that desert soils could be broadly divided into four populations based upon their soil aggregate populations. The differences between the four groups are based upon the estimated geometric mean diameter of the soil particles. The four size classes are 125 μm, 210 μm, 520 μm, and 690 μm, which are labeled FFS, FS, MS, and CS by Chatenet *et al*. (1996).

Using the Alfaro *et al*. (2003) approach, emissions of dust for soils can be confined to four different emission factors, depending on the geometric mean grain size, as determined by the methods of Chatenet *et al*. (1996). The model predictions were tested against the wind tunnel data set of Nickling and Gillies (1989) and found to fit the measured data satisfactorily. Of key importance is that Chatenet *et al*. (1996) established relationships between the 12 soil types that are defined in the classical soil texture triangle and their four dry soil types (silt [FSS], sandy silt [FS] silty sand [MS], and sand [CS]). The soil texture categorization and the relationships among texture assignments and soil groupings are discussed in the next section.

For the current methodology, the work of James et al. (2001) was considered, which reported emission rates as a function of wind speed and vacant land stability for a general soil type on surfaces free of vegetation and included the initial transient, or spike, emissions that occur at the onset of a wind event. Combining the relations of Alfaro and the emission rates of James et al., a hybrid methodology for the estimation of fugitive emissions from wind erosion was developed. The hybrid method uses the generic relations of James et al. and the soil texture specific relations of Alfaro to derive emission rates as a function of wind speed, soil texture and vacant land stability.

The result of combining the findings from these studies is presented in Figures 2-1 and 2-2. Figure 2-1 presents the emission rates for discreet wind speed bins for each of the five soil groups for disturbed, or unstable, vacant land parcels. The corresponding emission rates for undisturbed vacant lands are presented in Figure 2-2. The spike emissions for stable and unstable lands for each of the soil texture groups are presented in Tables 2-1 and 2-2, respectively. Note that the values presented here are applicable to land parcels with no vegetative cover.

In the WRAP methodology, dust emissions are initiated when the 10-meter wind speed exceeds the lower limit of the smallest wind speed bin for which data are available, as shown in Figures 2-1 and 2-2. The corresponding emission rates are then attenuated based on the percentage of vegetation canopy cover to account for the fact that the relations presented here are appropriate for a bare soil land parcel.

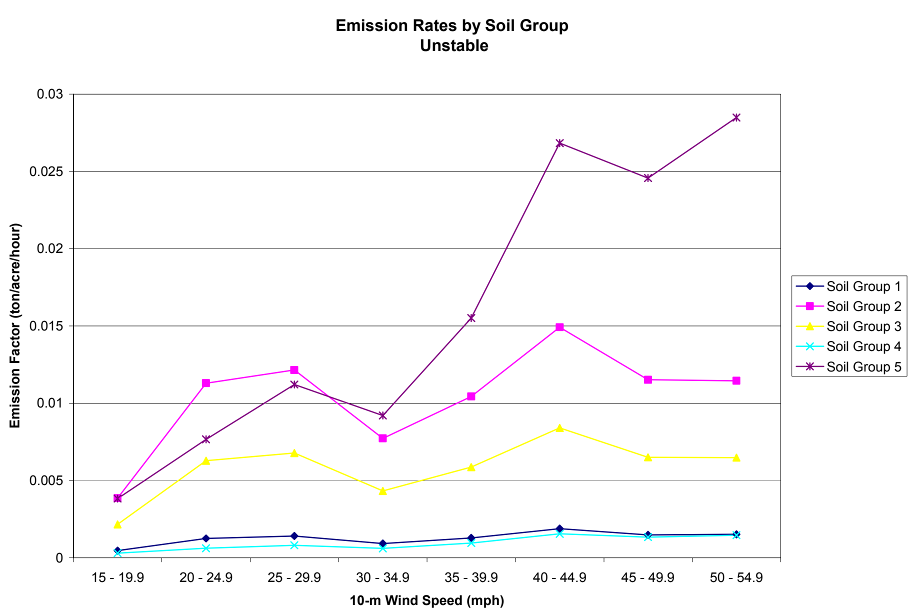


Figure 2-1. Emission factors by soil group for disturbed (unstable) soils.

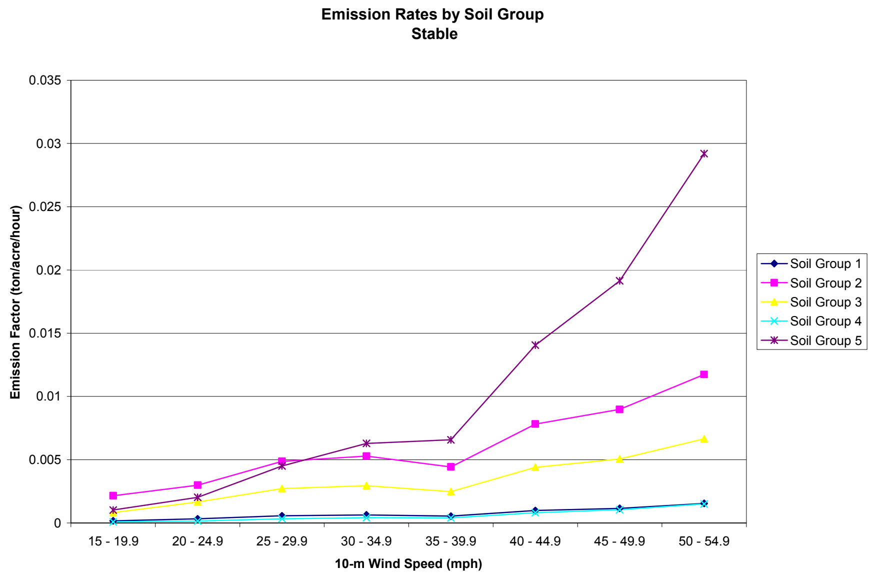


Figure 2-2. Emission factors by soil group for undisturbed (stable) soils.

Table 2-1. Spike emission by soil group for disturbed (unstable) soils.

			Spike Emission Unstable Soils (ton/acre)					
		10-m Wind Speed (mph)						
Soil Group	**15 - 19.9**	**20 - 24.9**	**25 - 29.9**	**30 - 34.9**	**35 - 39.9**	**40 - 44.9**	**45 - 49.9**	**50 - 54.9**
1	9.00E-05	2.34E-04	1.80E-04	3.90E-04	2.58E-04	6.36E-04	5.30E-04	6.36E-04
2	7.75E-04	2.09E-03	1.55E-03	3.24E-03	2.09E-03	5.02E-03	4.09E-03	4.80E-03
3	4.32E-04	1.16E-03	8.65E-04	1.82E-03	1.17E-03	2.83E-03	2.31E-03	2.72E-03
4	5.20E-05	1.15E-04	1.04E-04	2.57E-04	1.91E-04	5.21E-04	4.74E-04	6.16E-04
5	7.10E-04	1.42E-03	1.43E-03	3.87E-03	3.10E-03	9.02E-03	8.71E-03	1.19E-02

Table 2-2. Spike emission by soil group for undisturbed (stable) soils.

			Spike Emission Stable Soils (ton/acre)					
		10-m Wind Speed (mph)						
Soil Group	**15 - 19.9**	**20 - 24.9**	**25 - 29.9**	**30 - 34.9**	**35 - 39.9**	**40 - 44.9**	**45 - 49.9**	**50 - 54.9**
1	2.57E-05	5.13E-05	1.08E-04	1.18E-04	1.69E-04	2.85E-04	3.38E-04	3.64E-04
2	2.30E-04	4.60E-04	9.31E-04	9.83E-04	1.37E-03	2.24E-03	2.60E-03	2.75E-03
3	1.28E-04	2.55E-04	5.19E-04	5.51E-04	7.69E-04	1.26E-03	1.47E-03	1.56E-03
4	1.26E-05	2.52E-05	6.24E-05	7.80E-05	1.25E-04	2.33E-04	3.02E-04	3.53E-04
5	1.56E-04	3.12E-04	8.59E-04	1.17E-03	2.03E-03	4.04E-03	5.56E-03	6.85E-03

Soil Texture Categorization

Application of the emission factor relations described above requires the characterization of soil texture in terms of the 5 soil groups considered by the model. The characteristics, or type, of soil is one of the parameters of primary importance for the application of the emission estimation relations derived from wind tunnel study results. The State Soil Geographic Database (STATSGO) was used to determine the type of soils present in the modeling domain for which the emission inventory will be developed. The STATSGO database was developed by the Natural Resources Conservation Service of the U.S. Department of Agricultural (USDA) and provides detailed information concerning the taxonomy of the soils, including soil texture class, percentage of sand, silt and clay, and the available water capacity of the soil. While the complete STATSGO database available from the USDA includes numerous additional features, those features relevant for this project were considered to be the soils texture class. The soils data are available as geospatial coverages and associated attribute tables for each state in the US. Soils databases were obtained from the Earth System Science Center (ESSC) at Penn State University (http://www.essc.psu.edu/soil_info/).

The classification of soil textures and soil group codes is based on the standard soil triangle that classifies soil texture in terms of percent sand, silt and clay. Combining the soil groups defined by the work of Alfaro et al. (2003) and Chatenet et al. (1996) and the standard soil triangle provides the mapping of the 12 soil textures to the 4 soil groups considered in their study. Combining the data from these two soil texture/soil group mappings results in the unique mapping of soil textures to the soil groups for which emission factor data can be applied. Note that an additional soil group was added to distinguish loam soils defined by soil group code 3. The results of combining these soil texture definitions allows the assignment of the loam soil group in terms of standard soil texture. The soil texture mappings are summarized in Table 2-3.

Table 2-3. STATSGO soil texture and soil group codes.

STATSGO Soil Texture	Soil Texture Code	Soil Group Code
No Data	0	0
Sand	1	4
Loamy Sand	2	4
Sandy Loam	3	2
Silt Loam	4	1
Silt	5	5
Loam	6	3
Sandy Clay Loam	7	2
Silty Clay Loam	8	5
Clay Loam	9	3
Sandy Clay	10	2
Silty Clay	11	5
Clay	12	1

Vacant Land Stability

As shown in Figures 2-1 and 2-2 and Tables 2-1 and 2-2, the emission factors are a function of the stability of each land parcel. The stability refers to whether the land parcel is disturbed or undisturbed. The potential of each land parcel to emit fugitive dust increases dramatically for disturbed soils versus undisturbed soils. In general, the stability of the vacant land parcel is determined by the LULC categorization of each parcel.

Land use/Land cover was gridded at a resolution of 4-km and used in the determination of land cover types. The LULC data used in the study was based on the BELD3 LULC database as described in ENVIRON (2004). Data were processed at a gridded resolution of 4-km based on the 1-km resolution BELD3 LULC database. Within each 4-km grid cell, the percentages of each of the 29 BELD3 LULC categories were retained and used to determine the total area of each land use type within each 4-km grid cell.

The land use/land types, which can potentially emit wind-blown fugitive dust, are presented in Table 2-4. Note that this represents only a subset of the available land types within the database for use in the project. The land types, which are assumed not to emit fugitive dust, include water bodies, savanna, wetlands, tundra and snow and ice. Any land parcel for which soils data are missing or which are devoid of soils, i.e., bedrock, as determined by a soil group code of 0, are not included in the calculation of wind-blown fugitive dust. The classification of stability for urban lands is treated using a separate methodology as described below. Agricultural lands are also treated separately based on the agricultural adjustments discussed later.

Table 2-4. Stability of vacant land by LULC classification.

LULC Category	Stability
Urban	Stable/Unstable (see below)
Agricultural	--
Shrubland	Stable
Grassland	Stable
Forest	Stable
Barren	Unstable
Desert	Unstable

Treatment of Vacant Urban Lands

Urban lands are treated separately from other land use categories with respect to stability classification. Vacant urban land parcels are characterized as disturbed or undisturbed based on the percentage of land assumed to be core urban land versus boundary, or developing, urban land. Within urban areas a certain portion of the land is assumed to be vacant and disturbed, due either to new development or re-development, within the urban core. Within the boundary urban areas, there are generally more vacant disturbed areas than within the urban core, due to urban expansion and suburban development. Based on professional judgment and experience, an assumed constant percentage of disturbed versus undisturbed urban land is used for this study. Within the core urban areas, 8% of the land is assumed to be unstable, or disturbed, while 92% is stable. In urban boundary areas 70% of the land is assumed stable with 30% unstable. In each grid cell with urban lands, 8.33% of the urban land fraction is assumed to be boundary urban land while the remaining 91.67% of the area is considered core urban land. These assumptions are based on professional judgment and experience (Uhl, 2003).

Vegetative Cover Adjustments

The emission rates described above are based on vacant land parcels with no significant vegetation cover present. As noted above, increased canopy cover, or vegetation density affects emission rates of windblown fugitive dust. Increasing vegetation density decreases the overall emissive potential of vacant land parcels both by delaying the onset of saltation, as well as through a reduction in the shear stress in the intervening opening areas that drives the flux of soil particles at the surface. To account for these affects, the emission factors presented above are adjusted based on the percentage of vegetative canopy cover for each vacant land parcel.

A recent study White (2001) evaluated the emission flux rates of for soils under varying vegetation canopy cover percentages. Wind tunnel studies conducted by White for various wind speeds and percent vegetation cover indicate a significant reduction in average vertical flux of soils as the vegetation cover increases from 0% to 55% for all wind speeds considered. Attenuation factors based on average vertical flux data reported by White where developed for use in this study. Table 2-5 presents the relevant data from the White study and the emission rate reduction factors for vegetation cover percentages of 0, 11, 22 and 55%.

Table 2-5. Emission rates and attenuation factors by % vegetation cover.

Vegetation Cover %	ER by Formulation	Average Vertical Flux	ER by Raw Data	Attenuation Factor based on Avg. Vert. Flux
0	2989.17	2185.98	2064.95	1
11	1739.34	1530.76	1460.54	0.700263
23	459.86	427.11	541.21	0.195386
55	230.02	153.23	288.4	0.070097

The application of the attenuation factors displayed in Table 2-5 is dependent on the assumed vegetation density, or vegetation cover percentages, of each vacant land parcel. As discussed above, the LULC data for use in this project are based on the BELD3 database. This data set does not provide explicit information regarding vegetation density. Therefore, default vegetation cover percentages for each land use type available in the LULC data are assigned. The default vegetation densities, corresponding to the percentages shown in Table 2-5, for each land use type are presented in Table 2-6. Vegetation density assignments are based on information contained in the Vegetation Classification Standards of Federal Geographic Data Committee (FGDC, 1997). For agricultural lands, specific adjustments are applied to account for crop cover as discussed in the next section.

Table 2-6. Default vegetation cover percentages for each land use type.

LULC Category	Vegetation Cover %
Urban	55(stable)/0(unstable)
Agricultural	--
Shrubland	11
Grassland	23
Mixed Shrub/Grassland	17
Forest	55
Barren	0
Desert	0

Agricultural Land Adjustments

Unlike other types of vacant land, windblown dust emissions from agricultural land are subject to a number of non-climatic influences, including irrigation and seasonal crop growth. As a result, several non-climatic correction or adjustment factors were developed for applicability to the agricultural wind erosion emissions. These factors included:

- Long-term effects of irrigation (i.e., soil "clodiness");
- Crop canopy cover;
- Post-harvest vegetative cover (i.e., residue);
- Bare soil (i.e., barren areas within an agriculture field that do not develop crop canopy for various reasons, etc.); and
- Field borders (i.e., bare areas surrounding and adjacent to agricultural fields).

The methodology used to develop individual non-climatic correction factors was described in detail in ENVIRON, 2004. Most of these methods were based upon previous similar work performed by the California Air Resources Board (CARB) in their development of California-specific adjustment factors for USDA's Wind Erosion Equation (WEQ) (CARB, 1997). These correction factors were developed for specific soil textures, crop types, and geographic locations and then applied to the wind erosion estimates developed from the wind tunnel studies. Correction factors are developed only for the 17 field crops specifically identified in the BELD3.1 data set (i.e., alfalfa, barley, corn, cotton, grass, hay, oats, pasture, peanuts, potatoes, rice, rye, sorghum, soybeans, tobacco, wheat, and miscellaneous crops). Due to the insufficient characterization of the wind erosion emission processes for orchards and vineyards, correction factors for this type of agricultural land were not developed.

Meteorology

The application of the methodology described above requires the specification of meteorological fields, notably, wind speed, precipitation rates and soil temperatures. Hourly, gridded meteorological data was derived from CALMET simulations. CALMET was run at a 2-km horizontal spatial resolution. The model was configured vertically so as to generate 10-meter winds at layer 1. Options were used to simulate precipitation and soil temperatures. The meteorological model was run for the entire year 2002. The output data from CALMET was reformatted as NetCDF files with the appropriate meteorological fields required by the dust model including 10-meter wind speeds, soil temperature and precipitation rates.

<u>Wind Event Determination</u>

The determination of wind events follows the methodology of MacDougall, 2002. Following this approach, wind events are considered only when the 10-meter wind speeds reach or exceed the lowest defined wind speed bin for which emission factors are available, in this case 15 mph. Due to the limited availability of comprehensive wind tunnel studies, emission factors were derived only for 10-meter wind speeds of 15 mph or higher. The affect of stable versus unstable lands was incorporated using different emission factor relations for each type of vacant land parcel. The stability of vacant land parcels was based on LULC, as discussed previously. As detailed in MacDougall's methodology, a wind event may be defined as any time period for which the winds reach or exceed the threshold wind velocity separated by at least 12 hours.

Reservoir Determination

Because vacant land parcels do not have an endless reservoir of fugitive dust available for wind erosion, vacant lands must be characterized with respect to dust reservoirs. In addition, the reservoir designation of vacant lands will impact the potential for wind blown fugitive dust from the various land types present. Vacant land reservoirs were designated as limited or unlimited, based on the stability of land parcels, although a more accurate determination could be made if the soils database used for the study included more detail concerning the depth of the soil layer as discussed previously. Vacant land stability was defined based on the land use/land cover as discussed previously. Stable lands were assumed to have a limited reservoir available for wind erosion, while unstable lands were assumed to have unlimited reservoirs.

Stable, or undisturbed, land parcels are assumed to emit dust during the first hour of a wind event only, i.e., limited reservoirs are depleted within one hour. For unstable, or disturbed, land parcels, the reservoir will be depleted within 10 hours during any wind event. Reservoirs are recharged within 12 hours after a wind event, consistent with the assumption that a full 12 hours must elapse between wind events.

The assumed recharge characteristics for soil reservoirs under various conditions are summarized as follows:

- After a wind event, a reservoir will recharge within 12 hours.
- After rainfall event, a reservoir will recharge within 36 hours.
- After snow/ice cover has melted, a reservoir will recharge within 36 hours after the melt down.
- After a freeze period, a reservoir will recharge within 6 hours after the freeze period.

Precipitation Events

During precipitation events dust emissions are not generated. Precipitation events are determined by the rainfall rates available from the CALMET meteorological data. Given the limitations of the land use and soils databases used for the project, assumptions were made regarding the amount of rain necessary to decrease emission rates from wind erosion. Ideally, information concerning the soil moisture and available water capacity, and total rainfall over a specific time period would allow a more realistic treatment of precipitation events. For certain types of soils, dust may begin to emit due to wind erosion sooner than other soil types. In addition, the total amount of rain received over a given time period will have an affect on the amount of time required for the soils to dry out enough for wind erosion to initiate dust emissions. The resulting crusting of the soils after precipitation events is also a factor in determining the potential of a vacant land parcel to emit fugitive dust.

It is assumed that any amount of rain will prevent dust emissions due to wind erosion. The time required for these land parcels to begin emitting dust is assumed to be 36 hours after a precipitation event.

The presence of snow and freeze events were also considered in the development of the dust emission inventory. After the snow, or ice, cover has melted, as determined by the CALMET data, the reservoir will recharge within 36 hours after the meltdown. For freeze periods, as determined by the soil temperatures, reservoirs will recharge within 6 hours after the freeze period.

Summary of Methodology Implementation

For each grid cell, the land use and soil type are determined for each land parcel based on the soils and LULC databases. Stability and reservoir characteristics are then determined using the assumption described above. Hourly wind speeds are evaluated from the CALMET data. The appropriate emission factors as a function of wind speed, soil group and stability are obtained from Figures 2-1 and 2-2 and applied for each hour during the wind event. The emission factors are adjusted based on the assumed vegetation density using the attenuation factors given in Table 2-6. The spike emissions presented in Tables 2-1 and 2-2 are applied for the first hour only of each wind event. Based on the type of reservoir, i.e., limited or unlimited, dust emissions are generated for the duration of the wind event according to the assumptions described above concerning reservoir characteristics. Precipitation, soil surface freeze, and/or snow events are considered to determine whether the land parcel has the potential for dust emissions for any given hour and grid cell. Non-climatic agricultural adjustments are then applied to the agricultural land types, by county, crop type and month/season using the crop specific calendars and agricultural information assembled for the project. The recharge assumptions discussed above are considered and applied, as the data are processed hour by hour to generate the PM fugitive dust emission inventory.

The windblown fugitive dust model was applied for the calendar year 2002 at a spatial resolution of 4-km for the State of Arkansas. The model generates estimates of PM_{10} dust emissions. The fine fraction of dust is obtained by using a nominal $PM_{2.5}$ of 0.22, as used in the implementation of the model for the WRAP (ENVIRON, 2004). Hourly, gridded PM emissions were then aggregated to the county-level and summed for all hours of the year to obtain annual PM emission estimates. Typical summer weekday emissions were obtained by summing the results for June, July and August and dividing by the total number of days during that time. Likewise, typical winter weekday emissions are obtained by summing the results for December, January and February.

FUGITIVE DUST – AGRICULTURAL TILLAGE

Annual Emissions

Fugitive dust emissions from agricultural tillage were estimated using the quantity of total planted agricultural acreage for each of the six primary Arkansas field crops (i.e., corn, cotton, rice, sorghum, soybeans, and wheat). These acreages were obtained from statistics compiled by the Arkansas Agriculture Statistics Service (AASS, 2003a). Crop-specific acre-passes were obtained from crop budgets prepared by the University of Arkansas (UA, 2004). Crop-specific emission factors, based upon typical tillage practices, were obtained from recent work conducted in California's San Joaquin Valley (ARB, 2003). A $PM_{2.5}$ size fraction was applied to the PM_{10}

emission estimates in order to develop $PM_{2.5}$ emissions (ARB, 2002). Emissions from agricultural tillage were calculated using the following equation:

$$E_c = EF_c \times A_c \times AP_c \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lbs}} \right)$$

Where E_c = Emissions for crop c (tons PM_{10}/year);
EF_c = Emission factor for crop c (lbs PM_{10}/acre-pass);
A_c = Acreage for crop c (acres/year); and
AP_c = Acre-passes for crop c (acre-passes/acre).

A sample calculation using this equation for estimating agricultural tillage PM_{10} emissions from soybean fields in Pulaski County is as follows:

Where $A_{soybean}$ = 31,000 acres/year;
AP_{rice} = 2 acre-passes/acre;
EF = 1.48 lbs PM_{10}/acre-pass; and
$E_{soybean}$ = 45.9 tons PM_{10}/year.

Seasonal Emissions

Agricultural tilling operations occur only in certain months of the year. Arkansas crop budgets were examined to determine the occurrence period of tillage operations in Arkansas (UA, 2004). It was determined that there are no tillage operations associated with cotton, rice, sorghum, and wheat crops in Arkansas during the summer or winter seasons. Some tillage operations occur for corn in the winter and soybeans in the summer (i.e., approximately 20% of the total tillage operations for both corn and soybeans). Tillage operations were assumed to be uniform throughout the week.

FUGITIVE DUST – FEEDLOTS AND DAIRIES

Annual Emissions

Fugitive dust emissions from beef cattle feedlots and dairies were estimated using published livestock statistics (AASS, 2003a; AASS, 2003b; AASS, 2003c). Although there are nearly 2,000,000 head of beef cattle located in Arkansas, there are very few beef cattle feedlots located there (Mills, 2004). Most beef cattle are sent to out-of-state feedlots (i.e., Texas, Oklahoma, or Kansas) with in-state slaughter head counts totaling only 15,100 head (AASS, 2003b). The dairy cow population is approximately 33,000 head (AASS, 2003c). Beef cattle feedlot and dairy emission factors were obtained from recent work done in California's San Joaquin Valley (ARB, 2003). A $PM_{2.5}$ size fraction was applied to the PM_{10} emission estimates in order to develop $PM_{2.5}$ emissions (ARB, 2002). Average feedlot feeding period was assumed to be 120 days based upon various cattle feeding studies. Beef cattle feedlot and dairy cow populations were allocated to the county level based upon overall livestock populations.

Emissions from beef cattle feedlot and dairy cow fugitive dust emissions were calculated using the following equation:

$$E = EF \times P \times D \times \left(\frac{1\text{ ton}}{2{,}000\text{ lbs}} \right)$$

Where E = Emissions (tons PM_{10}/year);
EF = Emission factor for crop c (lbs PM_{10}/1000 head-day);
P = Population; and
D = Duration (days/year [120 days for feedlots; 365 days for dairies]).

A sample calculation using this equation for estimating fugitive dust emissions from dairies in Benton County is as follows:

Where EF = 4.4 lbs PM_{10}/1000 head-day;
P = 1,969 head;
D = 365 days; and
E = 1.6 tons PM_{10}/year.

Seasonal Emissions

Beef cattle feedlot and dairy activity was assumed to be constant throughout the year. Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

VOC SOURCES – PER CAPITA EMISSION FACTORS

Annual Emissions

Annual emissions for the following VOC source categories were estimated using per capita emission factors: architectural surface coatings, traffic markings, graphic arts, consumer solvents, and bakeries. Population statistics for 2002 were obtained from the Census Bureau (U.S. Census, 2003a). Per capita emission factors were obtained from EIIP guidance documents (EIIP, 1995; EIIP, 1997; EIIP, 1996a; EIIP, 1996b; EIIP, 1999d). National paint statistics were used to develop the per capita emission factors for architectural surface coatings and traffic markings (U.S. Census, 2003b). Per capita bread consumption statistics were used to develop the per capita emission factor for bakeries (EIIP, 1999d). A 20 percent reduction due to the promulgation of national VOC rules was applied to the architectural surface coating and consumer solvent use categories (i.e., the national VOC rules were promulgated after the date that the per capita emission factors were developed) (Federal Register, 1998a; Federal Register, 1998b).

The equation for estimating VOC source category emissions using per capita emission factors is:

$$E = EF \times P \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right) \times (1 - R)$$

where E = VOC emissions (tons/year);
EF = VOC per capita emission factor (lbs/person-year);
P = Population (people); and
R = Reduction due to national VOC rules (0.2 for architectural surface coatings and consumer products; 0 for graphic arts, traffic markings, and bakeries).

A sample calculation using this equation for estimating emissions for consumer solvent use in Pulaski County is as follows (the calculation is similar for the architectural surface coating, traffic markings, graphic arts and bakeries source categories):

where EF = 7.84 lbs VOC/person-year (from all consumer solvent product categories);
P = 364,381 people;
R = 0.2 and
E = 1,142.7 tons VOC year.

Seasonal Emissions

Architectural surface coating activity is temperature dependent with more activity in the summer and less in the winter. Summer and winter emissions were estimated based on national quarterly architectural coating shipments (U.S. Census, 2003b) where the 2nd and 3rd quarters were used for summer activity, and the 1st and 4th quarters were used for winter activity. Average summer and winter weekday emissions were calculated by dividing the seasonal emissions by the number of days in that season (i.e., 183 days for the 2nd and 3rd quarters and 182 days for the 1st and 4th quarters).

Traffic marking activity is based on the assumption that traffic paints are generally applied only when the temperature of the road surface is 50 ºF or higher. Therefore, it was assumed that there are no emissions from this source category in the winter season (i.e., December through February). The annual emissions were assumed to be uniform throughout the remaining active season. Activity was assumed to occur only during weekdays (EIIP, 1997a). Average summer weekday emissions were calculated by first estimating the summer season emissions (i.e., annual emissions multiplied by the ratio of summer season days over active season days) and then dividing by the number of summer weekdays (i.e., 65). Average winter weekday emissions were zero.

Graphic arts activity is assumed to have no seasonal fluctuations. However, activity is not uniform throughout the week (i.e., 75% of the activity occurs on weekdays, 20% on Saturdays, and 5% on Sundays) (EIIP, 1996a). Average weekday emissions were calculated by dividing annual weekday activity by the number of annual weekdays (i.e., 261); average weekday emissions for winter and summer were the same because of no seasonal fluctuations.

Consumer solvent and bakery activity is assumed to be constant throughout the year (EIIP, 1996b; EIIP, 1999d; EPA, 2002). Average summer and winter weekday emissions are assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

VOC SOURCES – PER EMPLOYEE EMISSION FACTORS

Annual Emissions

Annual emissions for the following VOC source categories were estimated using per employee emission factors: autobody refinishing, industrial surface coating, degreasing, and dry cleaning. County employee statistics for relevant NAICS codes (previously SIC codes) were obtained from the Census Bureau (U.S. Census, 2001). Per employee emission factors were obtained from EIIP guidance (EIIP, 2000a; EIIP, 1997b; EIIP, 1997c; EIIP, 1996c). A 33 percent reduction due to the promulgation of national VOC rules was applied to the autobody refinishing category (i.e., the national VOC rule was promulgated after the date that the per employee emission factors were developed) (Federal Register, 1998c).

The equation for estimating VOC source category emissions using per employee emission factors is:

$$E = EF \times EM \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lbs}} \right) \times (1 - R)$$

where E = VOC emissions (tons/year);
EF = VOC per employee emission factor (lbs/employee-year);
EM = Number of employees (people);
R = Reduction due to national VOC rules (0.33 for autobody refinishing; 0 for industrial surface coating, degreasing, and dry cleaning).

A sample calculation using this equation for estimating emissions for dry cleaning in Pulaski County is as follows (the calculation is similar for the autobody refinishing, industrial surface coating, and degreasing):

where EF = 1,800 lbs VOC/employee-year;
EM = 435 employees;
R = 0; and
E = 391.5 tons VOC year.

Seasonal Emissions

Activity for the per employee VOC categories of autobody refinishing, industrial surface coating, degreasing, and dry cleaning do not appear to have any significant seasonal variations.

It was assumed that activity for autobody refinishing, industrial surface coating, and degreasing only occur during the weekdays (i.e., 5 days/week). For these categories, average summer and winter weekday emissions were calculated by dividing annual emissions by 261 (i.e., number of weekdays in 2002).

Dry cleaning activity was assumed to occur on weekdays and Saturdays (i.e., 6 days/week). Average summer and winter weekday emissions were calculated by dividing annual emissions by 313 (i.e., number of weekdays and Saturdays in 2002).

ASPHALT PAVING

Emissions from asphalt paving were estimated using cutback asphalt usage estimates provided by the Arkansas Highway and Transportation Department (Bennett, 2004). The quantity of cutback asphalt used in Arkansas is considerably less than the quantity of hot-mix asphalt used; however, emissions from hot-mix asphalt are typically considered to be negligible (EIIP, 2001a). Cutback asphalt is primarily used for repairs and patching. Detailed tracking of cutback asphalt quantities is not available; however, it was estimated that between 5 to 10 tons of cutback asphalt (i.e., aggregate and binder combined) are used in each county (Bennett, 2004). It was assumed that counties with a population greater than 50,000 would use 10 tons of cutback asphalt per year; while counties with a population less than 50,000 would use 5 tons of cutback asphalt per year.

It was assumed that all cutback asphalt used was rapid cure with a diluent content of 35 percent (by weight). This corresponds to an evaporative loss of 24 percent (by weight) of the total cutback asphalt use (EIIP, 2001a).

Emissions from asphalt paving were calculated using the following equation:

$$E = M_c \times w\%_e$$

where E = Emissions (tons VOC/year);
M_c = Mass of cutback binder applied (tons/year); and
$w\%_e$ = Weight percent of asphalt evaporated.

A sample calculation using this equation for estimating emissions from cutback asphalt in Pulaski County is as follows:

where M_c = 0.5 tons/year;
$w\%_e$ = 24%; and
E = 0.12 tons VOC/year.

Cutback asphalt paving activity was assumed to be constant throughout the year (Bennett, 2004). Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

GASOLINE DISTRIBUTION

Annual Emissions

The gasoline distribution source category includes four subcategories: Stage I (underground tank filling), Stage II (vehicle refueling), underground tank breathing, and tank truck transit.

County-level gasoline sales were estimated by disaggregating state-level fuel sales using state and county vehicle registrations; fuel use by vehicle classification was estimated using detailed vehicle registration statistics that were disaggregated by vehicle classification (Porta, 2004). Stage I and Stage II controls have not been implemented anywhere in Arkansas (Swafford, 2004). In general, gasoline is transported via pipeline or barge to Arkansas bulk terminals and then transported from the bulk terminals to retail gasoline stations via tank truck (i.e., the gasoline transportation adjustment [GTA] factor is 1.0) (Swafford, 2004; Bailey, 2004).

Emission factors for Stage I tank filling, underground tank breathing, and tank truck transit were obtained from EIIP guidance (EIIP, 2001b); annual emissions were estimated using annual throughput. Stage II vehicle refueling emission factors were developed on a monthly basis for the county-level as part of the on-road motor vehicle emissions inventory development (see Section 3); these monthly emission factors were used to estimate monthly emissions which were then summed to estimate annual emissions.

Emissions from gasoline distribution were calculated using the following equation:

$$E = EF \times T \times \left(\frac{1\,\text{ton}}{2{,}000\,\text{lbs}} \right)$$

where E = Emissions (tons VOC/year or tons VOC/month);
EF = Emission factor (lbs/gal throughput); and
T = Annual fuel throughput (gal/year or gal/month).

A sample calculation using this equation for estimating emissions for Stage II refueling of light-duty gas vehicles in Arkansas County in January is as follows (annual emission estimates for Stage I, underground tank breathing, and tank truck transit are calculated in a similar manner):

where EF = 3.41 g VOC/gallon (7.52 lbs VOC/1000 gallons);
T = 567,070 gallons; and
E = 2.13 tons VOC.

Seasonal Emissions

As mentioned above, Stage II refueling emissions were initially estimated on a monthly basis. Stage I, underground tank breathing, and tank truck transit emissions were estimated on an annual basis and then allocated to each month based on statewide monthly gasoline sales (Porta, 2004). Seasonal emissions were then calculated by adding up the monthly emissions for the months in each season. Gasoline distribution activity was assumed to be constant throughout the week. Average summer/winter weekday emissions were calculated by dividing the seasonal emissions by the number of days in that particular season.

RESIDENTIAL OPEN BURNING

Annual Emissions

Residential open burning includes both burning of municipal solid waste (MSW) (i.e., trash/garbage) and yard waste (i.e., leaves and yard trimmings). Based upon regulations in Arkansas, open burning of MSW is prohibited (ADEQ Regulation 18.602) and open burning of yard waste is discouraged, but allowed (Act 1151 of 1997). However, open burning of both MSW and yard waste still occurs in many areas of Arkansas (Moore, 2004).

Initially, a mass balance approach was contemplated for estimating the amount of waste disposed of by open burning. However, available landfill and recycling statistics provided insufficient detail to accurately estimate emissions using this approach. Therefore, an alternative approach was used based on the U.S. National Emissions Inventory (NEI) methodology (Thesing and Huntley, 2001). Total quantities of generated MSW and yard waste were estimated using a national per capita waste generation rates. Arkansas-specific per capita waste generation rates have not been recently developed (Schneider, 2004). A per capita waste generation rate of 2.63 lbs/person-day was used for burnable MSW (i.e., paper, plastics, rubber/leather, textiles, and wood); while a per capita waste generation rate of 0.54 lbs/person-day was used for yard waste (Schneider, 2004; EPA, 2003). Nonburnable materials (i.e., glass, metal, miscellaneous organic wastes, and food scraps) were not considered in this approach.

A basic premise of this alternative approach is that residential open burning is only practiced by those portions of the population that live in rural areas as defined by the U.S. Census. Based upon the 2000 Census, Arkansas county rural fractions vary from 12.7% in Pulaski County to 100% in 16 counties (CSDC, 2004). These rural fractions were then applied to determine the quantity of rural waste generated. The alternative approach assumes that for rural populations, between 25 to 32 percent of all municipal waste is burned with a median value of 28 percent assumed as a national value. This value of 28 percent was applied to the quantity of rural waste generated to estimate the amount of rural waste burned.

Emission factors for residential yard waste and MSW were obtained from AP-42, Section 2.5 (EPA, 1995); recent studies have identified new PM_{10} and $PM_{2.5}$ emission factors for residential MSW burning (Thesing and Huntley, 2001). The emission factors for residential yard waste are weighted average emission factors which assume a yard waste composition of 50% grass clippings (not burnable), 25% leaves, and 25% brush.

Emissions from residential MSW and yard waste burning were calculated using the following equation:

$$E_p = EF_p \times P \times WG \times \left(\frac{365\text{ days}}{1\text{ year}}\right) \times \left(\frac{1\text{ ton waste}}{2{,}000\text{ lbs waste}}\right) \times RF \times BF \times \left(\frac{1\text{ ton}}{2{,}000\text{ lbs}}\right)$$

where E_p = Emissions for pollutant p (tons/year);
EF_p = Emission factor for pollutant p (lbs/ton);
P = Population;
WG = Per capita waste generation rate (lbs/person-day);
RF = Fraction of total population that is rural; and
BF = Fraction of rural waste that is burned.

A sample calculation using this equation for estimating CO emissions from the open burning of residential yard waste burning in Pulaski County is as follows (the calculation is similar for the open burning of MSW):

where EF_{CO} = 63 lbs CO/tons yard waste;
P = 364,381;
WG = 0.54 lbs waste/person-year;
RF = 0.127;
BF = 0.28; and
E_{CO} = 40.2 tons CO/year.

Seasonal Emissions

Emissions from open burning of yard waste or MSW do not demonstrate seasonal or weekly fluctuations (EPA, 2002). Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

WILDFIRES AND PRESCRIBED FIRES

Annual Emissions

Wildfire and prescribed fire statistics were provided by the Arkansas Forestry Commission (Russell, 2004; Holm, 2004). (Prescribed fires do not include agricultural fires). An average fuel loading of 9 tons/acre for Southern forests for wildfires was obtained from AP-42, Section 13.1 (EPA, 1995). Arkansas Forestry Commission estimated a fuel loading of 6 tons/acre for prescribed fires (Holm, 2002). Emission factors were obtained from AP-42, Section 13.1 (EPA, 1995).

Wildfire and prescribed fire emissions were calculated using the following equation:

$$E_p = EF_p \times AB \times FL \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lbs}} \right)$$

where E_p = Emissions for pollutant p (tons/year);
EF_p = Emission factor for pollutant p (lbs/ton);
AB = Acreage burned (acres/year); and
FL = Fuel loading (tons/acre).

A sample calculation using this equation for estimating VOC emissions from Pulaski County wildfires is as follows (the calculation is similar for prescribed fires):

where EF_{VOC} = 24 lbs VOC/ton;
AB = 241 acres;
FL = 9 tons/acre; and
E_{VOC} = 26.0 tons VOC/year.

Seasonal Emissions

Wildfires and prescribed burning do not occur uniformly throughout the year. Seasonal emissions estimates were based on monthly burned acreages (Russell, 2004; Holm, 2004). It was assumed that wildfire and prescribed burning activity is uniform throughout the week. Average summer and winter weekday emissions were calculated by dividing the seasonal emissions by the number of days in that season.

AGRICULTURAL BURNING

Annual Emissions

Total harvested acreage of the six primary Arkansas field crops (i.e., corn, cotton, rice, sorghum, soybeans, and wheat) were obtained from the Arkansas Agricultural Statistics Service (AASS, 2003a). University of Arkansas Cooperative Extension Service staff were contacted to determine the level of agricultural burning for each of these crops. Significant fractions of wheat and rice fields are burned (i.e., 70 percent and 22 percent, respectively), while smaller fractions of corn and sorghum fields are also burned (i.e., 5 percent and 1 percent, respectively). Cotton and soybean fields are not burned because of insufficient levels of post-harvest residue (Kelley, 2004; Robertson, 2004; Tingle, 2004; Wilson, 2004). Appropriate fuel loadings and emission factors were obtained from AP-42, Section 2.5 (EPA, 1995).

Emissions from agricultural burning were calculated using the following equation:

$$E_{p,c} = EF_{p,c} \times A_c \times BF_c \times FL_c \times \left(\frac{1\ \text{ton}}{2{,}000\ \text{lbs}} \right)$$

where $E_{p,c}$ = Emissions for pollutant p and crop c (tons/year);
$EF_{p,c}$ = Emission factor for pollutant p and crop c (lbs/ton);
A_c = Acreage for crop c (acres/year);
BF_c = Burn fraction for crop c; and
FL_c = Fuel loading for crop c (tons/acre).

A sample calculation using this equation for estimating VOC emissions from Pulaski County rice is as follows:

where $EF_{VOC,rice}$ = 8 lbs VOC/ton;
A_{rice} = 5,100 acres;
BF_{rice} = 0.22;
FL_{rice} = 3.0 tons/acre; and
E_{VOC} = 13.5 tons VOC/year.

Seasonal Emissions

Agricultural burning of crop residues does not occur throughout the year. University of Arkansas Cooperative Extension Service staff indicated the following burning periods: corn – late August and early September; rice – September and October; sorghum – September through November; and wheat – June (Kelley, 2004; Robertson, 2004; Tingle, 2004; Wilson, 2004).

Based on this information, it was assumed that the only crops burned during the summer are corn (half of total burned residue) and wheat (all residue); no agricultural burning occurs during the winter.

Agricultural burning activity was assumed to be fairly uniform throughout the week. Average summer weekday emissions were calculated by dividing the summer seasonal emissions by the number of days in summer (i.e., 92).

STRUCTURAL FIRES AND VEHICLE FIRES

Annual Emissions

The number of structural and vehicle fires that occurred in the state in 2002 was obtained from the Arkansas Fire Academy (Harcrow, 2004). It should be noted that these statistics are based upon voluntary reporting for the National Fire Incident Reporting System (NFIRS). Consequently, not all fire departments provided fire statistics. In addition, the 2002 statistics provided have not been entirely finalized (i.e., some late additions are possible). As a result, the actual number of structural and vehicle fires is probably higher than reported. However, the data collected from the Arkansas Fire Academy was used in the area source inventory without any extrapolation or data gap filling.

Structural fires were allocated to the county-level based upon population data (U.S. Census, 2003a); vehicle fires were allocated to the county-level based upon vehicle registration data (Porta, 2004)

The amount of material burned in a typical structural or vehicle fire, as well as appropriate emission factors, was obtained from EIIP guidance documents (EIIP, 2001c; EIIP, 2000b).

Emissions from structural fires and vehicle fires were calculated using the following equation:

$$E_p = EF_p \times F \times PF \times M \times \left(\frac{1\,\text{ton}}{2{,}000\,\text{lbs}} \right)$$

where E_p = Emissions for pollutant p (tons/year);
EF_p = Emission factor for pollutant p (lbs/fire);
F = Annual state fires (fires/year);
PF = Population fraction; and
M = Material burned per fire (tons/fire).

A sample calculation using this equation for estimating VOC emissions from Pulaski County structure fires is as follows:

where EF_{VOC} = 11.0 lbs VOC/tons;
F = 3,626 structure fires/year;
PF = 0.13445;
M = 1.15 tons/fire; and
E_{VOC} = 3.1 tons VOC/year.

Seasonal Emissions

Residential fires are most common during the winter months (i.e., 27% of annual fires occur during the months of December, January, and February); while only 24% of annual fires occur during the summer (i.e., June, July, and August) (NFDC, 2001).

For purposes of the inventory, it was assumed that the incidence of structural fires is fairly uniform throughout the week. Average summer weekday emissions were calculated by multiplying annual emissions by the seasonal occurrence rate of 24% and then dividing by the number of days during the summer. Average winter weekday emissions were calculated in a similar manner, except for using a seasonal occurrence rate of 27%.

The incidence of vehicle fires was assumed to be constant throughout the year (EIIP, 2000b). Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

LIVESTOCK AMMONIA

Annual Emissions

Annual ammonia emission estimates for livestock were obtained from a draft animal husbandry inventory developed for U.S. EPA's NEI (EPA, 2004b). This inventory utilized various manure management trains (MMTs) to develop county-level emission estimates for eight different types of livestock: beef cattle, dairy cattle, goats, horses, sheep, swine, chickens, and turkeys.

Seasonal Emissions

Livestock ammonia activity is assumed to be constant throughout the year. Average summer and winter weekday emissions are assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

FERTILIZER APPLICATION

Annual Emissions

Total harvested acreage of the five primary Arkansas field crops (i.e., corn, cotton, rice, sorghum, soybeans, and wheat) were obtained from the Arkansas Agricultural Statistics Service (AASS, 2003a). Fertilizer application is not required for soybeans (a legume). Typical fertilizer application procedures, quantities, and nitrogen contents were obtained from crop budgets prepared by the University of Arkansas (UA, 2004). Only nitrogen-containing fertilizers were included in the emission calculations; other types of fertilizers do not produce ammonia. Fertilizer-specific emission factors were obtained from U.S. EPA's ammonia emission factor document (Battye et al., 1994).

Emissions from fertilizer application were calculated using the following equation:

$$E_{f,c} = A_c \times AR_{f,c} \times N_f \times \left(\frac{1 \text{ ton N}}{2{,}000 \text{ lbs N}} \right) \times EF_f \times \left(\frac{1 \text{ ton } NH_3}{2{,}000 \text{ lbs } NH_3} \right)$$

Where $E_{f,c}$ = Emissions for fertilizer type f on crop c(tons NH_3/year);
A_c = Acreage of crop c (acres/year);
$AR_{f,c}$ = Application rate for fertilizer type f on crop c (lbs fertilizer/acre);
N_f = Nitrogen content of fertilizer type f (%); and
EF_f = Emission factor for fertilizer type f (lb NH_3/ton total N).

A sample calculation using this equation for estimating NH_3 emissions for urea application on wheat in Pulaski County is as follows:

Where A_{wheat} = 15,000 acres/year;
$AR_{urea,wheat}$ = 250 lbs urea/acre;
N_{urea} = 46% nitrogen content;
EF_{urea} = 364 lb NH_3/ton total N; and
$E_{urea,wheat}$ = 157.0 tons NH_3/year.

Seasonal Emissions

Fertilizer application activities depend on individual crop cycles and are not uniform throughout the year for any crop type. The Arkansas crop budgets indicate that the only relevant seasonal fertilizer application is urea (one-fourth rice quantity used in the summer and one-half wheat quantity used in the winter) and liquid nitrogen (full corn quantity used in the summer) (UA, 2004).

Seasonal emissions for relevant crops and fertilizers were calculated based upon seasonal fertilizer use. It was assumed that fertilizer application activities are uniform throughout the week. Average summer and winter weekday emissions were calculated by dividing the seasonal emissions by the number of days in that season (i.e., 92 for summer and 90 for winter).

DOMESTIC AMMONIA

Annual Emissions

The domestic ammonia source category includes a number of ammonia sources that are relatively small, if considered individually. However, collectively, these sources are more significant. The ammonia sources include pets (i.e., dogs and cats), human respiration and perspiration, cigarette smoke, household ammonia use, diapers (i.e., cloth and disposable), and human waste (i.e., homeless and other).

In general, per capita emission factors were used for most of the ammonia sources within the overall domestic ammonia source category (Radian, 1997). Overall population statistics for 2002, as well as infant population statistics, were obtained from the Census Bureau (U.S. Census, 2003a, U.S. Census 2000a). Additional information regarding the smoking and homeless populations was also collected (CDC, 2004a; CDC, 2004b; NCH, 2002). It was assumed that the distribution of diapers was 90% disposable and 10% cloth.

The general equation for estimating most types of domestic ammonia sources is:

$$E = EF \times P \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lbs}} \right)$$

where E = NH_3 emissions (tons/year);
EF = NH_3 per capita emission factor (lbs/person-year); and
P = Population (people).

A sample calculation using this equation for estimating household ammonia use emissions in Pulaski County is as follows:

where EF = 0.0507 lbs kg NH_3/person-year;
P = 364,381 people;
E = 9.2 tons NH_3 year.

The estimation of ammonia emissions from dogs and cats involves the use of "pet ratios" (i.e., the number of pets per 1,000 people in urban, suburban, and rural areas) (Radian, 1997). The estimation of ammonia emissions requires the fraction of the total population that smokes and a typical number of cigarettes smoked in a day (CDC, 2004a; CDC, 2004b).

Seasonal Emissions

The activities associated with domestic ammonia emissions were assumed to be constant throughout the year. Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

CHARBROILING

Annual Emissions

Emissions from charbroiling were estimated using a methodology previously employed in a PM_{10} inventory for Denver, Colorado (RAQC, 2001). The methodology was based upon annual per capita meat consumption and an estimated fraction of meals eaten away from home (RAQC, 2001). In addition, the estimated fraction of meat that is charbroiled was estimated from sales data of various types of restaurants (U.S. Census, 2000b). Population statistics were obtained from U.S. Census data (U.S. Census, 2003a).

Emissions from charbroiling were calculated using the following equation:

$$\mathrm{E} = \mathrm{P} \times \mathrm{MC} \times \mathrm{R} \times \mathrm{CB} \times \mathrm{EF} \times \frac{\text{ton } \mathrm{PM}_{10}}{2{,}000 \text{ lbs } \mathrm{PM}_{10}}$$

Where E = Emissions (tons PM_{10}/year);
P = Population (people);
MC = Meat consumption (lbs meat/person-year);
R = Fraction of meat consumed in restaurants (%);
CB = Fraction of restaurant meat that is charbroiled; and
EF = lbs PM_{10}/1000 lbs meat.

A sample calculation using this equation for estimating emissions in Pulaski County is as follows:

Where P = 364,381 people;
MC = 234 lbs meat/person-year;
R = 0.5;
CB = 0.1713;
EF = 24.07 lbs PM_{10}/1000 lbs meat; and
E = 87.9 tons PM_{10}/year.

Seasonal Emissions

Charbroiling activity was assumed to be constant throughout the year. Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

COLD STORAGE AMMONIA

Annual Emissions

County employee statistics for relevant NAICS codes 311 and 3121 (previously SIC code 20) were obtained from the Census Bureau (U.S. Census, 2001). A per employee emission factor was derived from national level employee statistics (U.S. Census, 2001) and national ammonia refrigerant use statistics (Battye et al., 1994; SRI, 2001).

The equation for estimating cold storage ammonia emissions using per employee emission factors is:

$$E = EF \times EM \times \left(\frac{1 \text{ ton}}{2{,}000 \text{ lbs}} \right)$$

Where E = NH_3 emissions (tons/year);
EF = NH_3 per employee emission factor (lbs/employee-year); and
EM = Number of employees (people).

A sample calculation using this equation for estimating emissions in Pulaski County is as follows:

Where EF = 248.6 lbs NH_3/employee-year;
EM = 1,521 employees; and
E = 189.0 tons NH_3 year.

Seasonal Emissions

Cold storage activity was assumed to be constant throughout the year. Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

MISCELLANEOUS LEAD SOURCES

Annual Emissions

Miscellaneous lead source emissions were obtained from the preliminary 2002 NEI (EPA, 2004a). For Arkansas, seven individual source categories were included:

- Animal cremation (Arkansas county only);
- Autobody refinishing (67 counties);
- Stage I aviation gasoline distribution (Benton, Pulaski, and Washington counties only);
- Commercial/institutional distillate fuel combustion (Benton, Craighead, Garland, Pulaski, Searcy, and Washington counties only);
- Commercial/instituation residual fuel combustion (Pulaski county only);
- Concrete, gypsum, and plaster products manufacturing (Independence, Union, and Washington counties only); and
- Industrial residual fuel combustion (Benton, Mississippi, Pulaski, Sebastian, and Washington counties only).

The Stage I aviation gasoline distribution source category was recalculated for 2002; all of the other source categories had been carried forward from the 1999 NEI. It is expected that these source categories will be developed for 2002 by U.S. EPA as data and resources become available.

The lead emissions for Stage I aviation gasoline distribution were for a specific lead compound (i.e., tetraethyl lead); all other categories are for unspeciated lead compounds.

Lead emissions for the three source categories that were already included in the Arkansas area source inventory (i.e., autobody refinishing, commercial/institutional distillate fuel combustion, and industrial residual fuel combustion) were added to emission summaries for those respective source categories. Lead emissions for the other four source categories (i.e., animal cremation; Stage I aviation gasoline distribution; commercial/institutional residual fuel combustion; and concrete, gypsum, and plaster products manufacturing) were aggregated together into the miscellaneous lead source category.

Seasonal Emissions

For those lead sources that were added to existing source category summaries, the seasonal emissions were calculated following the seasonal methodology used for other pollutants.

For the four lead sources categories that were aggregated together into the miscellaneous lead source category, it was assumed that activity was constant throughout the year. Average summer and winter weekday emissions were assumed to be equivalent to average daily emissions and were calculated by dividing annual emissions by 365 days.

3. 2002 ON-ROAD MOBILE SOURCE EMISSIONS

The category of on-road mobile source emissions includes emissions from vehicles certified for highway use – cars, trucks, and motorcycles. Emissions from these vehicles were estimated by combining EPA emission factors from the MOBILE6 model, expressed in grams per mile (g/mile), with vehicle miles traveled (VMT) activity data. For all of the Arkansas counties, county-level Highway Performance Monitoring System (HPMS) VMT data were used. This section describes details of the modeling procedures for estimating 2002 annual as well as summer and winter weekday emissions.

The data collection and emissions inventory development methodologies described below were conducted in accordance with ADEQ's Quality Assurance Project Plan (QAPP), as well as the requirements of the Consolidated Emissions Reporting Rule. All data collected as part of the on-road inventory were reviewed prior to use in emission calculations. All modeling inputs, data processing, and calculation spreadsheets were checked by a technical supervisor.

ACTIVITY DATA

Annual average daily HPMS VMT data were provided by the Arkansas Highway and Transportation Department (AHDT). These data were reported separately for urban and rural areas and within those categories, by county and HPMS facility class. The AHDT provided data for 2007 and 2010 and these were exponentially extrapolated back to 2002. To arrive at month-specific estimates, the annual average was adjusted using seasonal factors derived based upon data provided by AHDT. See Table 3-1. Finally, to obtain weekday VMT (for the summer and winter reporting requirements) the monthly values were corrected using Texas statewide average weekday/annual average daily factors: there are no default factors from EPA and these were considered to be the best, given the limited data available from only a few states. These are presented in Table 3-2.

Table 3-1. Seasonal VMT adjustment (from annual average daily basis) factors.

	Winter	Spring	Summer	Fall
Rural Interstate	0.912	1.028	1.057	1.002
Rural Other Principal Arterial	0.935	1.005	1.040	1.019
Rural Minor Arterial	0.905	1.014	0.991	1.089
Rural Major Collector	0.905	1.065	1.057	0.972
Rural Minor Collector	0.905	1.065	1.057	0.972
Rural Local	1.000	1.000	1.000	1.000
Urban Interstate	0.971	1.034	1.017	0.980
Urban Other Freeways and Expressways	0.991	1.005	0.981	1.023
Urban Other Principal Arterial	0.950	1.038	0.989	1.024
Urban Minor Arterial	0.984	1.015	0.994	1.008
Urban Collector	0.984	1.015	0.994	1.008
Urban Local	1.000	1.000	1.000	1.000

Table 3-2. Weekday/annual average day VMT correction factors.

Facility Class	Adjustment Factor
Rural Interstate	1.049
Rural Other Principal Arterial	1.041
Rural Minor Arterial	1.043
Rural Major Collector	1.040
Rural Minor Collector	1.027
Rural Local	1.043
Urban Interstate	1.049
Urban Other Freeways and Expressways	1.053
Urban Other Principal Arterial	1.041
Urban Minor Arterial	1.043
Urban Collector	1.027
Urban Local	1.043

MOBILE6 MODELING

General Approach

For each county, MOBILE6 emission factors were used in combination with the VMT data to estimate emissions by roadway type and vehicle class. National average speeds derived from HPMS data for each facility class were used. Monthly emissions were first estimated from which annual total, summer weekday, and winter weekday emissions were derived.

Overview of THE MOBILE6 Model

The EPA MOBILE6 model estimates emission factors (g/mile) by vehicle class, which are then multiplied by appropriate VMT estimates to estimate on-road vehicular emissions. The MOBILE6 model, released in January 2002, is the latest in a series of MOBILE models for estimating vehicular exhaust NOx, CO, and exhaust and evaporative VOC. Version 6.2, which is the latest publicly released version (February 2004) and available at http://www.epa.gov/otaq/m6.htm, was used in this work and includes emission factor estimates for SO_2, PM (at various size cutoffs), and NH_3. This version contains updated CO emission factors for light-duty vehicles certified to the National Low Emission Vehicle (NLEV) and Tier 2 standards.

The MOBILE6 model includes the effects of all currently promulgated Federal motor vehicle control programs:

- Tier 1 light-duty vehicle standards, beginning with the 1994 model year;
- National Low Emission Vehicle (NLEV) standards for light-duty vehicles, beginning with model year 2001;
- Tier 2 light-duty vehicle standards, beginning with model year 2004;
- Heavy-duty vehicle standards, beginning with model year 2004; and
- Heavy-duty vehicle standards (with low sulfur diesel), beginning with model year 2007.

MOBILE6 Inputs

MOBILE6 was run to generate the gram per mile emission factors. MOBILE6 can model either January 1st or July 1st of each calendar year. For this work, monthly emission factors were generated in accordance with EPA guidance. January through June were modeled as January while the remaining months were input as July. In this particular case, the specification of the month only affects the registration distribution. Details of the MOBILE6 inputs used are described below.

Speeds by Facility Type

MOBILE6 models four facility types: freeway, arterial, local, and ramp, each with a unique assumed driving cycle used for emission factor calculations. When modeling a freeway or arterial, the user can specify a speed ranging from 2.5 to 65mph. For modeling to be used with HPMS activity, a VMT-weighted average speed by facility class by area type (urban/rural) was calculated from EPA's average speeds by roadway and vehicle type (www.epa/otaq/reports/env-spds.htm), as shown in Tables 3-3 and 3-4.

Table 3-3. Urban roadway types and speeds used in MOBILE6 modeling.

Roadway Type	MOBILE6 Roadway Type	VMT-weighted Average speed (mph)
Interstate	Freeway	43.8
Freeways & Expressway	Freeway	43.8
Principal Arterial	Arterial	19.4
Minor Arterial	Arterial	19.4
Collector	Arterial	19.4
Local	Local	19.4

Table 3-4. Rural roadway types and speeds used in MOBILE6 modeling.

Roadway Type	MOBILE6 Roadway Type	VMT-weighted Average speed (mph)
Interstate	Freeway	55.6
Principal Arterial	Arterial	43.8
Minor Arterial	Arterial	38.8
Major Collector	Arterial	33.8
Minor Collector	Arterial	29.4
Local	Local	29.4

Fleet Characterization

From previous work, calendar year 2000 local registration distribution data were available for the four counties in the Little Rock area. In agreement with ADEQ and AHDT, these registration data were used in the 2002 MOBILE6 modeling as follows. The four counties for which data were available used these directly. For the remaining counties, ADEQ provided urban/rural designations. In general, rural counties were then assigned Lonoke County's distribution, suburban counties were assigned the average of Saline and Faulkner Counties, and the others used weighted averages. The local registration distribution data show that the fleet in Arkansas is older on average than the national default. Appendix Table A-3 provides the complete assignments. There were no local data on the VMT mix; the MOBILE6 default VMT mix was therefore used.

Temperature and Humidity

2002 monthly average daily minimum/maximum temperature and relative humidity data were obtained for each of nine regions comprising the state. This is described in more detail in the non-road section of this report. For on-road use, the relative humidity values were converted to absolute (grains/pound dry air) values using EPA's tool available at http://www.epa.gov/otaq/m6.htm#m60.

Altitude

Arkansas counties were modeled with the low altitude setting in MOBILE6.

Fuel Inputs

Summer (May through August) gasoline fuel volatility (Reid vapor pressure, RVP) was set at 7.6 psi, while winter months (November through February) were modeled using 12.7 psi. Spring (March and April) and autumn (September and October) were assumed to have gasoline with 9.6 psi RVP. These values are based upon a combination of information from the Arkansas Bureau of Standards and survey data from the National Institute for Petroleum and Energy Research (NIPER, 1994 and 1995). Sulfur content was set at 300 ppm and 500 ppm for gasoline and diesel, respectively. These are national conventional fuel averages. Neither reformulated gasoline nor oxygenated fuel was in use in Arkansas in 2002.

Inspection and Maintenance

Arkansas does not have an I/M or anti-tampering program.

Application of MOBILE6 Emission Factors

Gram-per-mile emission factors for VOC (total minus refueling), CO, NO_x, PM_{10}, $PM_{2.5}$, SO_2, and NH_3 were obtained for each county, month, roadway type, area type (urban/rural) and eight MOBILE5 vehicle classes. These were then multiplied with the corresponding VMT to estimate emissions. The annual total emissions were obtained by summing the monthly emissions. To obtain seasonal weekday emissions, the weekday-adjusted VMT were used to estimate emissions for the season's months and these were then averaged (with the number of weekdays in each month as the weighting factors).

4. OFF-ROAD EMISSIONS METHODOLOGY

This section describes the methods used to estimate off-road emissions for calendar year 2002. Off-road mobile sources encompass a wide variety of equipment types that either move under their own power or are capable of being moved from site to site. More specifically, these sources, which are not licensed or certified as highway vehicles, are defined as those that move or are moved within a 12-month period and are covered under the EPA's emissions regulations as nonroad mobile sources. Where feasible and appropriate, local activity data for specific source categories were gathered and used to develop the inventory.

US EPA's draft NONROAD2002 model (June 2003 version) was used to estimate emissions for most off-road sources. The NONROAD model estimates emissions from nonroad equipment in the following categories:

- agricultural equipment, such as tractors, combines, and balers;
- airport ground support, such as terminal tractors;
- construction equipment, such as graders and back hoes;
- industrial and commercial equipment, such as fork lifts and sweepers;
- residential and commercial lawn and garden equipment, such as leaf and snow blowers;
- logging equipment, such as shredders and large chain saws;
- recreational equipment, such as off-road motorbikes and snowmobiles; and
- recreational marine vessels, such as power boats.

Aircraft, commercial marine and locomotive emissions are also included in the off-road inventory, but these sources were estimated separately since they are not included in the NONROAD model. General EPA methodologies were followed to estimate emissions for these three categories.

For all source categories, annual average emissions have been estimated in tons per year, and ozone season and winter season daily emissions are estimated in tons per day.

The data collection and emissions inventory development methodologies described below were conducted in accordance with ADEQ's Quality Assurance Project Plan (QAPP), as well as the requirements of the Consolidated Emissions Reporting Rule. All data collected as part of the of-road sources emission inventory were thoroughly reviewed prior to use in emission calculations. In addition, all emission factors used in the inventory were reviewed to ensure that they were the most appropriate and up-to-date emission factors available. Finally, all modeling inputs, modeling output processing, and spreadsheet calculations used for emissions estimation for each off-road source category were checked for calculational accuracy by a technical supervisor.

NONROAD MODELING

The EPA NONROAD2002 model was used to estimate emissions for all off-road mobile source categories except locomotive, commercial marine and aircraft. The most recent draft version publicly released by EPA is the June 2003 version (core model version 2.1), available on the

NONROAD model web site at http://www.epa.gov/oms/nonrdmdl.htm; that version of the model was used in this effort. Although the NONROAD model is in draft form and is still evolving, it has been used to develop the EPA National Emissions Inventories for 1999 and 2002, and also in recent SIP modeling efforts which have been accepted by EPA.

The NONROAD model estimates emissions for six exhaust pollutants: VOC, NO_X, CO, CO_2, SO_X, and PM (both PM_{10} and PM2.5). The model also estimates emissions of non-exhaust HC for six modes — hot soak, diurnal, refueling, resting loss, running loss, and crankcase emissions. It provides emission estimates at the national, state, and county level. County-level emissions are determined by allocating the state level estimates using econometric or other activity indicators, such as employees, tilled acreage, and construction valuation. The NONROAD model can be directed to yield seasonal, monthly or annual emission estimates on a period total or typical day basis. The latter can also take into account weekday/weekend differences.

The NONROAD model incorporates the effects of equipment emission certification standards through a dynamic age distribution calculation. The national non-road emission standards included in the model are applicable to:

- Diesel engines
- Small gasoline engines (handheld and non-handheld equipment <25 hp)
- Recreational marine gasoline engines
- Recreational and commercial marine diesel engines

The model includes more than 80 basic and 260 specific types of nonroad equipment, and further stratifies equipment types by horsepower rating and fuel type. The basic equation for estimating emissions in the NONROAD model is as follows:

$$Emissions = (Pop)*(Power)*(LF)*(A)*(EF)$$

where

Pop = Engine Population
Power = Average Power (hp)
LF = Load Factor (fraction of available power)
A = Activity (hrs/yr)
EF = Emission Factor (g/hp-hr)

For national or state level emissions estimation, the corresponding engine population is determined and then multiplied by the average power, activity, and emission factors. National average engine power, load factor (the relative fraction of maximum available power that engine uses on average), annual activity, and emission factors can be directly used to calculate the national annual total emissions. For county level estimates, equipment population by county must first be estimated in the model by geographically allocating the correct state engine population through the use of econometric or physical indicators, such as construction valuation or water surface area. The manner in which the geographic allocation is performed is as follows:

$$(County\ Population)_i /(State\ Population)_i = (County\ Indicator)_j /(State\ Indicator)_j$$

where

i is an equipment application like construction or agriculture.
j is an indicator type associated with equipment i

Activity is temporally allocated with an analogous equation, but using monthly and day of week fractions of yearly activity.

The NONROAD model has default estimates for most variables and factors used in the calculations. All of these estimates are in model input files, and can be changed by the user if data more appropriate to the local area are available. The following sub-sections describe modifications to NONROAD model inputs that were made for this work.

Model Inputs and Application

The NONROAD model requires specification of several inputs. Fuel Reid vapor pressures from the Arkansas Bureau of Standards were provided by ADEQ. Table 4-1 shows the RVP standards for various periods of the year. However, locally measured values are more preferable since most refiners typically leave a margin of safety with respect to the standard. Thus NIPER fuel survey data from 1993-1994 (see Table 4-2) were used in conjunction with the above standards to arrive at the final RVP values. A RVP of 7.6 psi was assumed for summer (May – Aug). A RVP of 12.7 psi was used for the winter months (Nov – Feb) while 8.9 psi and 10.6 psi were used for the spring (Mar – Apr) and autumn (Sep – Oct), respectively. The spring and autumn values are weighted averages of the monthly RVP for the months contained in each season. Considering the base sulfur levels specified by the EPA at http://epa.gov/air/caaac/diesel_sulfur_w97.pdf and http://www.ntec.org/air/factsheet3.html, a gasoline sulfur content of 300 ppm and diesel sulfur content of 3400 ppm were proposed to ADEQ and used in the modeling.

Monthly minimum and maximum temperatures and relative humidity corresponding to year 2002 were obtained from the National Climate Data Center (NCDC) at http://www.cdc.noaa.gov/Timeseries/ and http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/avgrh.html, respectively. The data are available through the NCDC by region as defined for Arkansas at http://www.ncdc.noaa.gov/img/onlineprod/drought/ar.gif.

Data for each county corresponds to one of the 9 regions defined for Arkansas based on their geographic location. Appendix Table A-1 shows the listing of Arkansas counties under each of the 9 climatic regions.

Table 4-1. Fuel RVP from Arkansas Bureau of Standards.

Period of Year	RVP in psi
January 1-15	15.0
January 16 – March 15	13.5
March 16 – April 15	11.5
April 16 – September 15	9.0
September 16 - October 15	11.5
October 16 – December 31	15.0

Table 4-2. Fuel RVP from NIPER fuel surveys.

Period of Year	RVP in psi
Winter 1993-1994 (Dec 93-Feb 94)	12.7
Summer 1994 (Jun-Aug 1994)	7.6

Additionally, the default state recreational marine vessel population was updated using registration data obtained from the Arkansas Office of Motor Vehicles (OMV) (Beaver, 2004). These data report the total certificates of number issued as of January 4, 2003. Vessels are reported by length and engine location (inboard or outboard). Based on conversations with OMV staff, it was assumed that population listed as "Other Watercraft" is predominantly personal watercraft (PWC). Inboard, outboard and PWC populations were separately apportioned by fuel type, engine technology, and horsepower range using the existing default distributions. The results replaced the defaults in the NONROAD2002 population input file for Arkansas.

Both the annual and the seasonal modeling have been done for each county independently. Appendix Table A-2 shows the NONROAD inputs by season for the 75 counties of Arkansas. For annual emissions estimation, the NONROAD model was run for each season to obtain seasonal total emissions, and the annual emissions in tons per year were obtained by taking the sum of these seasonal VOC, NOx, CO, PM10, and SOx emissions. Seasonal NONROAD runs were also executed using the summer and winter fuel RVPs and temperatures and the weekday option to obtain summer and winter seasonal weekday emissions.

The NONROAD model does not estimate ammonia emissions. However, gasoline (non-catalyst) and diesel ammonia emission factors based on fuel consumption are available. These are to be used in EPA's emission inventory estimates for 2002 using EPA's new NMIM model information available at NMIM
ftp://ftp.epa.gov/EmisInventory/prelim2002nei/mobile/nmim_related/
For this effort, gasoline and diesel equipment are assumed to emit ammonia at a rate of 116 mg and 83.3 mg per gallon of fuel consumption, respectively. PM2.5 emissions were obtained by applying a factor of 0.92 to the diesel and gasoline emissions and a factor of 1.0 for CNG and LPG emissions.

Growth Factors

NONROAD default equipment populations are mostly based on either 1996 or 1998 data from Power Systems Research, a private marketing research company (EPA, 1998). ENVIRON decided not to use the default NONROAD growth factors because questions have been raised concerning their validity. Instead, ENVIRON developed alternative state-level growth factors using different surrogates for each non-road equipment category and assumed linear growth to forecast the 1996 or 1998 base year data to 2002. Table 4-3 shows the list of surrogate types and final growth factors used to project population/activity in each non-road equipment category. These growth factors were applied to the emission estimates obtained from the NONROAD model to produce emissions estimates for the year 2002.

Table 4-3. Growth indicators used to adjust NONROAD output emissions to 2002 levels.

Source Category	Growth Indicator (Reference)	Growth Factor
Airport GSE	Air Carrier Landing & Takeoff Cycles (FAA, 2002)	0.731
Agricultural	Agricultural GSP (BEA, 2001)	1.138
Agricultural Swathers	Agricultural GSP (BEA, 2001)	1.222
Commercial & Industrial	Total GSP (BEA, 2001)	1.117
Construction	Construction GSP (BEA, 2001)	1.148
Lawn & Garden	Human Population (Campbell, 1996), equipment base year 1996	1.066
Lawn & Garden	Human Population (Campbell, 1998,) equipment base year 1998	1.041
Logging	Lumber and Wood Products GSP (BEA, 2001), equipment base year 1998	1.005
Logging Chainsaws	Lumber and Wood Products GSP (BEA, 2001), equipment base year 1996	1.007
Oil Field	Oil & Gas GSP (BEA, 2001)	0.545
Pleasure Craft	Boat Registration, 2002*	1.000
Recreational	Human Population (Campbell, 1996)	1.041
Underground Mining	Mining GSP (BEA, 2001)	1.144

* Since year 2002 population was used, no additional growth adjustment is required.

LOCOMOTIVE

The locomotive source category includes engine exhaust emissions associated with freight line-haul, passenger, and switching locomotive activity. This source category is a significant off-road category for NOx, SO_2 and PM emissions. The major emissions in this category are from Class I railroads, the largest railroads: primarily Union Pacific (UP), Burlington Northern Santa Fe (BNSF), and Kansas City Southern (KCS), which are the largest freight railroads. Other smaller Class II/III railroads and AMTRAK passenger rail also operate within Arkansas.

Survey data were provided by the largest railroads operating in Arkansas, UP and BNSF. These are summarized in Table 4-4. In addition, the Little Rock Port Authority also provided an activity rate (Pinkerton, 2002). A summary of the other fuel consumption estimates, as described in more detail below, is provided for comparison and demonstrates that UP and BNSF are the primary railroads operating in Arkansas.

Table 4-4. Surveyed and estimated fuel consumption by railroad.

Railroad	Line-Haul	Switching
UP (survey)	75,368,389	2,045,350
BNSF (survey)	12,424,591	329,960
LRPA (survey)	---	8,280
KCS (estimate)	2,551,659	201,975
Class II/III other than LRPA (estimate)	4,590,000	500,000
AMTRAK (estimate)	526,659	---

One other larger railroad, Kansas City Southern (KCS), operates in western Arkansas. KCS operations were estimated by apportioning the national fuel consumption of KCS (51,256,604 gallons for line-haul and 4,057,180 gallons for switching) using the ratio of state (217) to national (4359) track mileage. The resulting estimated state fuel consumption is shown in Table 4-4.

In order to estimate potentially important small rail activity, the national fuel consumption per railroad employee was used and associated with local employment information. Benson (2004) prepared the national estimates of fuel consumption and employees shown in Table 4-5 from annual surveys conducted by ASLRRA (1999). Nationally, Class II/III rail is of lesser importance than the Class I rail, which consumes nearly 20 times the fuel that these smaller rail systems consume nationwide. The fuel consumption and employees estimates in Table 4-5 are national summary estimates, and correspond to 10,000 gallons per employee. By contrast, the Class I railroad fuel consumption per employee ranges from 16,000 to 31,000 gallons per employee, possibly due to longer haul trips where fewer employees are required per ton-mile of operation.

Table 4-5. Class II/III railroads national summary activity rates.

Year	Employees	Fuel Consumption (gallons)
1993	24,000	200,000,000
1994	25,000	225,000,000
1995	24,000	225,000,000
1996	24,000	200,000,000
1997	No data available	
1998	23,000	210,000,000
1999	23,000	220,000,000
2000	22,000	220,000,000
2001	22,000	220,000,000

This estimate of fuel consumption per employee was used in this work to estimate the smaller rail fuel consumption rates using estimates of the number of employees for each company as provided from a purchased database of Dun & Bradstreet (D&B). The AAR and D&B data also indicated whether the railroad was considered a typical (line-haul) railroad or only provided switching services, so that the appropriate emission factors for line-haul or switching operations were applied to the correct operation.

For AMTRAK, the routes and schedules were used to determine the number of trains through Arkansas. The number of trains and mileage was multiplied by 2.35 gallons per train-mile (based on an estimate provided by AMTRAK [Jurczak, 2003]) to estimate the fuel consumption for AMTRAK trains.

Emission factors used in this work were derived from EPA documents provided as support documentation for the 1997 locomotive emission standards (EPA, 1997). The emission rates per gallon of fuel consumed are higher with switching engines because the duty cycle is on average lower power with a significant amount of idle, so the engine does not operate as efficiently as possible. Emission rates are higher for smaller rail systems than Class I railroad operations because they have been expected to convert more slowly to lower emissions engines (EPA, 2004a). Harvey (2004) provided the ammonia emission rates using the latest available data. The emission factors used in this work are shown in Table 4-6.

Table 4-6. Emission factor estimates used in this work (grams per gallon).

Engine Type	HC	CO	NOx	PM	SOx[1]	NH3[2]
Precontrolled 1999 Line-haul	10	26.6	270	6.7	16.7	0.116
Precontrolled 1999 Switching	21	38.1	362	9.2	16.7	0.116
Including emission reductions expected with the EPA rulemaking (% Reduction)						
2002 Class I Line-haul	9.99 (0.1%)	26.6	238.3 (11.8%)	6.7	16.7	0.116
2002 Class I Switching	21	38.1	355.8 (1.7%)	9.2 (0.02%)	16.7	0.116
2002 Class II/III Line-haul	10	26.6	268.9 (0.4%)	6.7	16.7	0.116
2002 Class II/III Switching	21	38.1	360.5 (0.4%)	9.2	16.7	0.116
2002 Passenger	9.99 (0.1%)	26.6	253.0 (6.3%)	6.7	16.7	0.116

[1] Reported as SO_2 and derived from an average sulfur level of 2600 ppm (EPA, 2004c).
[2] Harvey (2004)

Multiplying the fuel consumption estimates and survey results by the emission factors produces emissions estimates. The state estimated locomotive emission totals by class are shown in Table 4-7.

Table 4-7. State emission totals (tons/year).

Railroad	HC tons/year	CO tons/year	NOx tons/year	PM tons/year	SOx tons/year	NH3 tons/year
Class I	1,060	2,773	24,889	697	1,720	12
Class II/III	62	156	1563	39	94	1
Total	1,123	2,929	26,452	736	1,814	12.6

The survey results from UP and BNSF (and LRPA) were provided as county specific emissions, so the county allocations were completed directly from the data provided. For other railroad emissions, the allocations were performed using the track mileage provided by BTS (2002) GIS files. AMTRAK trains run regular routes so the emissions were apportioned according to those routes by relative mileage through each county where AMTRAK operates.

COMMERCIAL MARINE

Commercial marine activity in Arkansas area occurs along the Mississippi, Arkansas (McClellan-Kerr navigation system), Ouachita, and White Rivers. The Red River is reported to be navigable in Arkansas, but no freight traffic along the Red in Arkansas could be found. The commercial marine traffic is exclusively due to barges pushed by tugs supplying the propulsion power.

Bray et al., 2002 and Drager, 2003 provided estimated total ton-miles and fuel consumption along each river using a sophisticated model accounting for wait times at locks, empty barges, and other variables to produce their estimates. The TVA fuel consumption estimates for the rivers of interest in this work are shown in Table 4-8.

Table 4-8. Barge and tug fuel consumption by river.

River	1999	2000	2001
Ouachita and Black	542,546	706,830	605,136
White River	115,683	69,989	100,308
Arkansas	5,767,800	4,933,280	5,954,795
Mississippi (Between Ohio Confluence and Baton Rouge)	205,685,090	215,788,544	192,157,145

Because the activity on the rivers and river segments were not wholly contained within the State of Arkansas for the Ouachita, Arkansas, and Mississippi Rivers, an allocation method was required to determine the fraction of the activity in Arkansas. For the rivers with locks, Ouachita and Arkansas Rivers, the ton-miles of freight above and below locks were estimated for the entire river, and the fuel consumption was apportioned according to the relative ton-miles of freight within Arkansas to the river total. For the Mississippi River where there are no locks in the long river segment, the river mileage was used to apportion the fuel consumption to the state and county as shown in Table 4-9. Only half of the emissions were allocated to Arkansas, assuming the rest would be counted in the emissions from the adjoining States of Tennessee and Mississippi. The White River activity, including canals, is wholly contained within Arkansas running between the Mississippi and Arkansas Rivers, so the river mileage was used to apportion 70 percent of the activity to Desha County with the remainder in Arkansas County.

Table 4-9. Mississippi River activity apportionment.

	Downstream Border	Upstream Border	Total in County	Percent of River (Baton Rouge - Ohio R.)	Percentage, Corrected for Border Issue
County	River Miles				
Baton Rouge		230			
Chicot	507	554	47	6.5%	3.3%
Desha	555	619	64	8.9%	4.4%
Phillips	620	673	53	7.3%	3.7%
Lee	674	696	22	3.0%	1.5%
Crittenden	697	753	56	7.7%	3.9%
Mississippi	755	828	73	10.1%	5.0%
Ohio River	953				

The Army Corps of Engineers records freight movements through the locks systems along the river (http://www.iwr.usace.army.mil/ndc/), which affords an estimate of activity in terms of ton-miles of transport. The 2001 tonnages (the latest year available) at each of the locks in Arkansas are shown in Tables 4-10 and 4-11 for the Ouachita and Arkansas Rivers with the river mileage associated with each lock. The freight traffic though each lock was converted to a ton-mile estimate using the freight movements and river mileage. The tonnage moved typically decreases at each lock up the river. The tonnage moving to and from the upper lock was multiplied by the distance between the locks and added to the difference in tonnage between the upper and lower lock multiplied by half the distance between the two locks. This method produced a ton-mile estimate for use in allocating the fuel consumption by river segment.

Table 4-10. Tonnage freight traffic at each lock and tons moved between locks on the Ouachita and Black Rivers.

River Point	River Mileage	Total Tons (1000)	Ton-Miles (1000)
Mississippi Confluence	0		41,200
Jonesville	25	1648	
			158,630
Columbia	117.2	1793	
			208,185
AR - LA Border			
Fesenthal	226.8	2006	
			117,843
HK Thatcher	281.7	2287	
			92,166
Camden	322	2287	
Highest Navigable Point			618,024
Arkansas Traffic Fraction of River Total			34%

Table 4-11. Tonnage freight traffic at each lock and tons moved between locks on the Arkansas River.

River Point	River Mileage	Total Tons (1000 tons)	Ton-Miles (1000)
Mississippi Confluence			89,579
Norrell	10.3	8697	
			26,082
#2	13.3	8691	
			309,536
Joe Hardin	50.2	8086	
			127,869
Emmet Sanders	66	8100	
			158,817
Lock #5	86.3	7547	
			163,936
David Terry Lock	108.1	7493	
			123,150
Murray Lock	125.4	6744	
			202,383

River Point	River Mileage	Total Tons (1000 tons)	Ton-Miles (1000)
Toad Suck Ferry Lock	155.9	6527	
			136,815
Arthur V. Ormond	176.9	6503	
			189,532
Dardanelle	205.5	6751	
			291,153
Ozark - Jeta Taylor	256.8	4600	
			165,798
James W. Trimble	292.8	4611	
			119,729
W.D. Mayo Lock	319.6	4324	
AR Border	330		71,911
Robert S. Kerr Lock	336.2	4340	
			129,565
Webber Falls Lock	366.6	4184	
			136,016
Chouteau Lock	401.4	3633	
			71,831
Newt Graham Lock	421.6	3479	
			63,309
Port of Catoosa	445	1932	
Highest Navigable Point			2,577,011
Arkansas State Traffic Fraction of River Total			83%

The fuel consumption estimates were converted to emissions using EPA (1999) emission factor estimates. The EPA (1999) emission factors in Table 4-12 were provided by engine type for those below and above 1000 kW rated power.

From the Coast Guard data (http://www.iwr.usace.army.mil/ndc/veslchar/veslchar.htm) the push boats registered in the State with installed propulsion power less than 2,680 hp (2000 kW), assuming two engines per boat, represented 62 percent of the push boat installed power. This figure was used to provide average emission factors for push boats in Arkansas. The emission factor was converted to grams per gallon using an average specific fuel consumption figure of 210 g/kW-hr (same figure as for locomotives) and a fuel density of 7.1 pounds/gallon.

Table 4-12. EPA (1999) emission factors for marine engines.

Engine	HC (g/kW-hr)	NOx (g/kW-hr)	CO (g/kW-hr)	PM10 (g/kW-hr)	SO2[1] (g/gal.)	NH3[1] (g/gal.)
<1000 kW	0.27	10	1.5	0.30	16.7	0.116
>1000 kW	0.27	13	2.5	0.30	16.7	0.116
Average emission rates in g/gallon						
Average 62% Engines <2500hp	4.14	170.8	28.8	4.60	16.7	0.116

[1] Using the same emission rates as for locomotives

Dredging contracts in the Little Rock District of the Army Corps were distributed along the Arkansas River (McClellan-Kerr Navigational System). Typical dredging activity along this river system has averaged approximately 1,000,000 cubic yards (http://www.iwr.usace.army.mil/ndc/drgcorps.htm) per year with the 1,667,000 cubic yards dredged in 2001, the latest year available for this study. Emission estimates are shown in Table 4-13 using an emission estimate from another study (Starcrest, 2000) where emissions were estimated and associated with tonnage of material dredged. The emissions were estimated based on total material dredged in Arkansas and were then distributed along the length of the river.

Table 4-13. Dredging activity and emissions estimates.

Area	Tonnage (cu. yards)	HC (tons/year)	NOx (tons/year)	CO (tons/year)	PM (tons/year)	SO2*	NH3*
Houston (Starcrest,2000)	5,667,000	1.8	143.3	25.7	3.6	-	-
2002 AR	1,667,000	0.5	42.2	7.6	1.1	22.9	0.18

* No direct estimates were available so a ratio of the NOx value was used for the SO2 and NH3 estimates.

Combining the river traffic and emission factors and adding dredging emissions, county level emissions estimates for commercial marine were prepared and are shown in Table 4-14. As would be expected, the counties bordering the Mississippi River exhibit the highest emissions.

Table 4-14. Commercial marine emissions (tons per year) by county.

County	HC	NOx	CO	PM – 10	SO2	NH3
Arkansas	2.0	83.4	14.1	2.2	9.5	0.1
Ashley	0.0	0.9	0.2	0.0	0.1	0.0
Bradley	0.0	1.5	0.3	0.0	0.1	0.0
Calhoun	0.1	2.9	0.5	0.1	0.3	0.0
Chicot	28.5	1176.1	198.5	31.7	115.0	0.8
Clark	0.1	2.9	0.5	0.1	0.3	0.0
Conway	1.4	58.2	9.9	1.6	6.9	0.0
Crawford	1.2	49.3	8.4	1.3	5.9	0.0
Crittenden	34.0	1401.4	236.5	37.7	137.0	1.0
Dallas	0.0	1.1	0.2	0.0	0.1	0.0
Desha	39.9	1644.5	277.5	44.3	160.9	1.1
Faulkner	0.9	37.7	6.4	1.0	4.4	0.0
Franklin	1.5	65.4	11.1	1.8	8.1	0.1
Jefferson	4.4	187.1	31.7	5.0	21.4	0.2
Johnson	0.9	39.1	6.6	1.1	4.7	0.0
Lee	13.3	550.5	92.9	14.8	53.8	0.4
Lincoln	1.5	64.2	10.9	1.7	7.3	0.1
Logan	1.0	44.3	7.5	1.2	5.4	0.0
Mississippi	44.3	1826.8	308.3	49.2	178.6	1.2
Ouachita	0.1	4.8	0.8	0.1	0.5	0.0
Perry	0.9	37.4	6.3	1.0	4.4	0.0
Phillips	32.1	1326.3	223.8	35.7	129.7	0.9
Pope	1.2	48.9	8.3	1.3	5.8	0.0
Pulaski	3.4	143.6	24.3	3.9	16.7	0.1
Sebastian	1.1	47.2	8.0	1.3	5.6	0.0

County	HC	NOx	CO	PM – 10	SO2	NH3
Union	0.1	3.7	0.6	0.1	0.4	0.0
Yell	1.0	43.7	7.4	1.2	5.2	0.0
State Total	*215.0*	*8893.1*	*1501.2*	*239.5*	*888.1*	*6.2*

AIRCRAFT

The method currently recommended by the Federal Aviation Administration (FAA) for estimating aircraft emission inventories of CO, HC, NOx and SOx at airports employs the FAA's Emissions and Dispersion Modeling System (EDMS). The EDMS model, an airport emissions and air dispersion modeling program (information available at http://www.aee.faa.gov/emissions/edms/EDMShome.htm), combines specified aircraft and activity levels with default emission factors in order to estimate annual inventories for a specific airport. Aircraft activity levels in EDMS are expressed in terms of landing and take-off cycles (LTOs), which consist of the four aircraft operating modes: taxi and idle, take-off, climb-out, and approach. Default values for the amount of time a specific aircraft spends in each mode, or the time-in-modes (TIMs), are included in EDMS (except for taxi/idle) but may be updated with airport-specific values where available. In addition, the model also includes updateable default settings for the mixing height and aircraft engine assignments. In order to use EDMS, a separate setup and model run for each airport is required, and each combination of aircraft model, engine type, and activity level to be considered in the modeling scenario must be explicitly specified. Due to this input-intensive procedure, and because the current version of the model lacks the capability to automate the setup for each model run, it was not possible to use EDMS to estimate emissions for all airfields in Arkansas given the available resources.

In addition, a review of available air traffic statistics from the FAA indicated that the aircraft model-specific activity data needed to support a detailed analysis of emissions from all flight categories are not currently available. Aircraft activity data in varying levels of detail may be obtained for all flight categories at airports with FAA managed traffic control towers, which only keep detailed activity records on air carrier traffic and less detailed records for the other flight categories. The different flight categories are:

- Air carriers (AC), which are larger turbine-powered commercial aircraft with at least 60 seats or 18,000 lbs payload capacity;
- Air taxis (AT), which are commercial turbine or piston-powered aircraft with less than 60 seats or 18,000 lbs payload capacity;
- General Aviation Aircraft (GA), which typically are small piston-powered, non-commercial aircraft; and
- Military Aircraft (MA).

Currently available fleet data are inadequate to run the EDMS model for air taxis and (in most cases) military aircraft since little detail are kept in control tower records, and for general aviation aircraft flights, which occur mostly at non-towered facilities. Non-towered facilities tend to have very limited information on activity levels and do not, as a normal practice, keep detailed records on airframe types for flights in and out of the facility.

In order to estimate emissions given these data inadequacies, a mixed methodology was used in developing the aircraft CO, HC, NOx, SOx, and PM10 emissions inventories. The methodology employed the EDMS model for airports/flight categories with detailed information on aircraft activity and used fleet-average (aggregate) emission factors for the rest of the analysis. A similar aggregate method of analysis has been employed by EPA to estimate aircraft emission inventories, such as in developing the 1996 National Toxics Inventory (NTI). Ammonia and lead emissions were estimated separately as discussed below.

Ninety-nine towered airports were identified in the state of Arkansas (from www.airnav.com/airports/us/AR). For 76 of these airports, flight category-specific aircraft activity data were obtained from FAA's Terminal Area Forecast (TAF). For 23 of the remaining smaller airports, activity data were obtained from the website www.airnav.com.

In addition, for a previous inventory developed for the Little Rock area, the ADEQ provided detailed activity data for military aircraft at the Little Rock Air Force Base (LRAFB) and an Army National Guard installation. In addition to LTO and fleet composition, estimates of TIMs were provided.

EDMS Modeling

For the five largest airports in Arkansas, EDMS modeling was used to estimate emissions from Air carriers and Air taxis:

- Adams Field (LIT), Little Rock
- Fort Smith Regional Airport (FSM), Fort Smith
- Drake Field Airport (FYV), Fayetteville
- Texarkana Regional Airport-Webb Field (TXK), Texarkana
- Northwest Arkansas Regional Airport (XNA), Fayetteville

Required taxi/idle time information was acquired from the Bureau of Transportation Statistics (BTS) at http://www.bts.gov/ntda/oai/SummaryStatistics. The taxi/idle time was estimated by summing the reported taxi-in and taxi-out times for each airport.

Fleet composition data were available from the Bureau of Transportation Statistics (BTS) for air carriers and air taxis at each of these five airports (1999 fleet mix data was scaled to 2002 using activity data from the TAF).

The taxi/idle time, airframe types and associated LTO in the fleet composition data were entered into the FAA EDMS model v4.12. Once executed, EDMS gave the HC, NOx, CO and SOx emissions that correspond to the total LTOs in the fleet composition data. These emissions were distributed to the air carrier and air taxi categories for each airport based upon LTO data.

The emissions for each of the military airfields were addressed previously using the EDMS. For this work, these emissions, which represented calendar year 2000, were scaled to 2002 levels using state military GSP available at http://www.bea.doc.gov/bea/regional/gsp/. HC emissions were converted to VOC using EPA (1992) conversion factors for commercial aircraft.

PM emissions for these aircraft were estimated using emission factors specific to each engine type from the 1997 Final Emissions Impact Report for the Oakland International Airport (Port of

Oakland, 1997). All other parameters (TIMs, engine assignments, etc...) were the same as used in the EDMS modeling.

Aggregate Approach

Flight category-specific criteria emission factors obtained from EPA (1992) were used to estimate the emissions by combining with the FAA activity data for air taxis (except for those five larger airports which were modeled by EDMS), general aviation and military aircraft. Table 4-15 shows the emission factors for VOC, NOx, CO and PM10 for each aircraft category. The FAA activity data were converted to LTO cycles by dividing by 2 as the criteria emissions factors are in lbs/LTO cycle.

Table 4-15. Aircraft emission factors (lbs/LTO unless otherwise noted).

Pollutant	Air Taxis	General Aviation	Military Aircraft
NOx	0.158	0.065	0.158
CO	28.13	12.014	28.13
VOC	1.223 (0.9914 times HC)	0.382 (0.9708 times HC)	1.363 (1.1046 times HC)
SOx	0.015	0.01	0.015
PM10	0.60333	0.2367	0.60333
NH3	~0	153.47 mg/gal	~0

Lead Emissions Estimation

Lead was estimated separately using an emission factor (1.5 g/gal) multiplied by the amount of aviation gas consumed. This methodology followed that which was used in the 1996 NTI. The amount of fuel consumed (at the airports) was calculated as described above.

Ammonia Emissions Estimation

Commercial and military aviation were assumed to be dominated by turbine-powered aircraft running lean, thus producing a negligible amount of ammonia. For general aviation, a fleet-average fuel consumption rate was first developed from EDMS data for three popular piston engines (O200, O320, and TSIO-360). The operational mode-specific fuel flowrates were weighted by the time spent in each mode; taxi/idle time was from BTS and the rest from EDMS. That rate was converted from kg/second to gallons/hour assuming a fuel density of 0.75 kg/liter. The total hours of operation (at the airports) were estimated using the TIM information (hours/LTO) and the GA LTO data from FAA TAF. The NH_3 emission factor for non-catalyst light-duty gasoline vehicles used in EPA's 1986-1999 emissions trends calculations (EPA, 2001) was then applied.

Seasonal Emission Estimation

Monthly emissions were obtained by using the ratios of monthly to annual total LTO data from the ATADS at http://www.apo.data.faa.gov/faaatadsall.HTM. Emissions for the June through August ozone season were summed and then divided by the number of days in this period to obtain the ozone season daily emissions. In a similar manner, the winter season daily emissions were estimated. (Note that no difference between weekday and weekend was assumed due to lack of data.) The monthly LTO data from the ATADS were only available specifically for six airports (ASG, FSM, FYV, LIT, TXK, and XNA) but an average profile calculated from these six was applied to the other airfields as well.

5. SUMMARY AND DISCUSSION OF EMISSION RESULTS

This section provides a summary and discussion of the estimated area, on-road, and off-road source emissions by pollutant for the eight pollutants required to be reported under CERR: VOC, NOx, CO, PM10, PM2.5, SOx, NH3, and Pb. Statewide emissions summaries are provided for each major source category for calendar year 2002, and for 2002 typical winter weekday and typical summer weekday. ENVIRON is providing to ADEQ along with this report a set of summary spreadsheets that tabulate emissions by detailed SCC for each county in the state.

This section also describes the data and procedures used to spatially allocate the area, on-road, and off-road emissions to develop the gridded emission inventories. Plots are provided that show the gridded emissions by major source category for each pollutant and for each of the three time periods (annual, summer weekday, and winter weekday).

AREA SOURCE EMISSIONS

Area source emissions estimates for the state for calendar year 2002 are presented by source category in Table 5-1. The 2002 summer weekday emission estimates are presented in Table 5-2, and the 2002 winter weekday emission estimates are shown in Table 5-3. Figures 5-1 through 5-7 show the relative contribution by source category grouping to annual area source emissions. The primary VOC sources are, in order of magnitude for the state as a whole: prescribed burning, industrial surface coatings, gasoline distribution, agricultural burning, solvent use, and residential wood combustion. The primary NOx sources are industrial fuel combustion and prescribed burning; these two categories account for about 60 percent of total NOx emissions. CO emissions are dominated by agricultural and prescribed burning; these two categories account for almost 90 percent of total CO emissions. About half of PM_{10} emissions are from fugitive road dust; other large sources of PM10 are windblown dust, agricultural tillage, and prescribed burning. For PM2.5, the largest contributors are prescribed burning, unpaved roads fugitives, and agricultural burning. SO_X emissions are almost completely from industrial fuel combustion. NH3 emissions are largely (92 percent) from livestock and fertilizer application.

OFF-ROAD EMISSIONS

Table 5-4 shows the 2002 annual off-road emissions by source category. Tables 5-5 and 5-6 show the off-road summer and winter weekday emissions, respectively, by source category. Figures 5-8 through 5-14 show the relative contribution by source category to annual off-road emissions. The relative emissions contributions by source category are similar in the annual, summer weekday, and winter weekday time periods. VOC emissions are dominated by recreational marine equipment and recreational equipment; these two categories account for more than half of the annual VOC emissions from off-road equipment. Three source categories account for about 75 percent of the annual NOx emissions – locomotives, commercial marine, and agricultural equipment. The largest source of CO emissions is from lawn and garden equipment (about 30 percent of annual emissions). Agricultural equipment is the largest source of particulate matter emissions, almost 40 percent of annual PM10 and PM2.5; locomotives and construction equipment account for another 32 percent of annual PM10 and PM2.5. SOx emissions from off-road sources are dominated by agricultural equipment and locomotives (together about 55 percent of annual emissions); other large sources of SOx emissions are construction equipment and commercial marine. Ammonia emissions from off-road engines and equipment are insignificant compared to area sources. The only lead from off-road sources is from general aviation, which used leaded gasoline.

ON-ROAD EMISSIONS

Table 5-7 shows the 2002 annual on-road emissions by vehicle class. Tables 5-8 and 5-9 show the summer and winter weekday emissions, respectively, by vehicle class. Figures 5-15 through 5-21 show the relative contribution by vehicle class to annual on-road emissions. The relative emissions contributions by vehicle class are similar in the annual, summer weekday, and winter weekday time periods. Almost all of the VOC and CO emissions (more than 90 percent) are from light-duty cars and trucks. About 42 percent of NOx emissions are from heavy-duty diesel vehicles, and about 50 percent of NOx emissions are from light-duty vehicles. For PM10, almost 60 percent of the on-road emissions are from heavy-duty diesel trucks, and about 35 percent are from light-duty vehicles. For PM2.5 emissions, the heavy-duty diesel fraction is even larger – almost 70 percent, and about 25 percent is from light-duty vehicles. Light-duty vehicles account for about 60 percent of SOx emissions, and heavy-duty diesel accounts for about 33 percent. Ammonia emissions from on-road vehicles are very small compared with area sources, and are almost all from light-duty vehicles.

GRIDDED EMISSIONS

Emission Gridding Surrogate Development

Spatial allocation of regional or county-level emission estimates is accomplished through the use of gridding surrogates or spatial allocation factors (SAFs) for each emission source category or group of source categories. Spatial surrogates are typically based on the proportion of a known region-wide characteristic variable that exists within the modeling domain grid cells. Traditionally the development of spatial gridding surrogates has been performed by a variety of methods depending on the emission source category being considered, the required spatial resolution, the geographic extent of the domain, and the particular characteristics of the geospatial data available. Spatial surrogates must define the percentage of regional or county level emissions from a particular source category that is to be allocated to some spatial region, typically a modeling grid cell. For most area and off-road sources, these percentages are based on areas of a particular land use/land cover type while for on-road mobile source categories, the percentages are usually based on total length of a certain road type or a transportation network. Often human population is also used as a spatial surrogate for certain emission source categories.

Gridding surrogates were developed from several sources of spatial data describing the Land Use/Land Cover (LULC), transportation networks and population characteristics.
Land use data were obtained from the USGS EROS Data Center web site (http://edcftp.cr.usgs.gov/pub/data/landcover/states) and are a subset of the National Land Cover Dataset (NLCD). This dataset provides dominant land use data for each state at a spatial resolution of 30 meters. The 21 LULC categories and codes utilized in the NLCD are presented in Table 1. More detailed descriptions of the NLCD land use types are available

from the USGS web site. These eight bit binary files were imported into the Arc/INFO geographic information system (GIS) as raster images and then converted to polygon coverages. Due to the high resolution of the LULC data, Arc/INFO cannot directly generate polygon coverages at this resolution. Therefore, the data were re-sampled at a resolution of 2 kilometers prior to conversion to polygons. The resulting polygon coverages could then be overlayed first with state and county boundary files and then with the appropriate grid file.

Population and housing statistics were obtained from the EPA's gridding surrogate GIS datasets. The EPA has recently assembled numerous datasets from a variety of sources for development of gridding surrogates for emissions processing. The housing and population data were derived from the 2000 US Census. Roadways and railways were derived from the US Census Bureau TIGER/Line data files. Additional spatial surrogate information, specifically information on airport and shipping port locations, were also obtained from spatial surrogate data developed by the EPA (ftp://ftp.epa.gov/EmisInventory/emiss_shp2003/).

The processing and development of gridding surrogates was performed using the Arc/INFO GIS. To develop gridding surrogates, or SAFs, the appropriate surrogate databases (i.e., land use, population, roadways, railways, etc), the modeling domain grid, and the regional/county boundaries are first imported into the GIS as geospatial coverages. Through intersecting, or overlaying, these coverages, the appropriate areal and/or linear percentages can be calculated as follows. The spatial data are first intersected with the regional boundaries to generate a new coverage that contains polygons, or arcs, with attribute associated with the spatial data and the regional boundaries. The total area, or length, of a particular land use, or roadway type, within each region or county can then be calculated. The resulting coverage is then overlaid with the modeling domain grid to associate the grid cell attributes (i and j cell indices) with the land use and regional boundary attributes. These procedures result in the generation of new polygons, each of which has all of these attributes as well as the corresponding areas, or lengths. The spatial allocation factors are then generated by forming ratios of the total area, or length, in each grid cell and county to the corresponding total area, or length of the particular spatial data type within each county. The resulting coverage was then exported as a text data file containing the fractional area, or length, for each spatial data type in each grid cell referenced by county FIPS codes. The resulting data were then reformatted using Perl to provide the required gridded surrogate data file input to the EPS2 emissions modeling system.

Spatial Surrogate Assignments

To apply the emissions processing system using the spatial gridding surrogates developed as described above, the LULC codes listed in Table 5-10 need to be aggregated and re-mapped to the surrogate codes recognized by EPS. Table 5-11 displays the mapping of NLCD codes to EPS gridding surrogate codes.

The US EPA's SCC-spatial surrogate cross-reference files were evaluated for use in the project. In most cases, the EPA's surrogate assignments are based on fairly broad surrogate categories (i.e., population, rural land, agricultural land, etc.). As EPS2 allows surrogates to be user-defined using more detailed categorization of LULC classifications for specific application, the EPA-defined surrogate assignments were compared with those typically used by ENVIRON when developing modeling inventories using EPS2. It was determined that the EPA's surrogate assignments were considerably less detailed than the most recent allocation assignments typically used by ENVIRON. Therefore, the more refined SCC-surrogate assignments developed by ENVIRON were used. The use of these assignments result in improved spatial allocation of various emission source, particularly off-road sources, which EPA's assignment allocates mostly to population, rather than specific land use types for which the activity data associated with these sources are more appropriate.

Table 5-12 summarizes the spatial allocation data for the treatment of area, on-road mobile and off-road mobile emission sources, and provides the description of each emission source category, the unique SCC code(s) assigned to each and the corresponding spatial surrogate category/codes.

Example displays of residential, agricultural and Industrial/Commercial land surrogates are presented in Figures 5-22 through 5-24, respectively.

Gridded Emission Results

The gridded emissions results for summer and winter weekday emissions are provided in a series of graphical displays as follows:

- Area sources, summer weekday – Figures 5-25 to 5-31
- Off-road sources, summer weekday – Figures 5-32 to 5-38
- On-road sources, summer weekday – Figures 5-39 to 5-45
- Area sources, winter weekday – Figures 5-46 to 5-52
- Off-road sources, winter weekday – Figures 5-53 to 5-59
- On-road sources, winter weekday – Figures 5-60 to 5-66

In each set, the pollutants are in the same order: VOC, CO, NOx, PM10, PM2.5, SOx, and NH3. For all of the displays, the scale is set to range from the minimum to the maximum emissions by source category and pollutant; i.e., the same scale is used for both summer and winter weekday emissions for each source category/pollutant combination. Because the emissions in the state by source category and pollutant can range from relatively small in rural areas to relatively large in urban areas, for some plots most of the shading is on the green lower end of the scale with only small areas in other colors for the urban areas. On-road emissions outside the urban areas are also on the green end of the scale outside the urban areas, but follow the major roadways in the state.

NIF FORMATTING OF EMISSIONS

The county-level emissions by detailed SCC are being provided in EPA NIF format to the ADEQ along with this report. EPA's NIF 3.0 has been developed to standardize submission of data for creating the 2002 National Emission Inventory (NEI), which integrates criteria pollutant data for VOC, NO_x, CO, SO_2, PM_{10}, $PM_{2.5}$, NH_3, and Pb with data for 188 hazardous air pollutants (HAPs). The format, instructions, and conventions for using the NIF are available on the EPA web site at http://www.epa.gov/ttn/chief/nif/. The NIF-formatted data files are Microsoft Access MDB files. Note that the tables in the off-road MDB file are named "area" because the current version of NIF includes off-road sources in with area sources (future versions of NIF may identify off-road emissions separately). All NIF files created were run through EPA's NIF Format and Content Checker (recently updated and released on May 18, 2004) to ensure compatibility for upload. The output files from this Checker are also being provided to ADEQ along with this report.

Table 5-1. AR 2002 Annual Area Source Emissions by Category in tons per year.

Category	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	SO_x	NH_3	Pb
Residential Wood Combustion	6,178	225	18,101	2,485	2,485	34	0	0
Industrial Fuel Combustion - Natural Gas	204	10,400	3,120	282	282	22	119	0
Industrial Fuel Combustion - LPG	25	1,387	236	41	41	1	0	0
Industrial Fuel Combustion - Distillate Fuel	17	2,089	435	87	22	8,201	70	0
Industrial Fuel Combustion - Residual Fuel	0	0	0	0	0	0	0	0
Industrial Fuel Combustion - Coal	8	1,193	954	954	350	18,127	0	0
Commercial Fuel Combustion - Natural Gas	91	1,650	1,386	125	125	10	8	0
Commercial Fuel Combustion - LPG	4	145	20	5	5	0	0	0
Commercial Fuel Combustion - Distillate Fuel	3	170	42	9	7	723	7	0
Residential Fuel Combustion - Natural Gas	116	1,974	840	160	160	13	10	0
Residential Fuel Combustion - LPG	20	824	114	26	26	1	0	0
Residential Fuel Combustion - Distillate Fuel	0	0	0	0	0	2	0	0
Residential Fuel Combustion - Kerosene	0	10	3	1	0	3	0	0
Paved Roads	0	0	0	30,305	7,576	0	0	0
Unpaved Roads	0	0	0	135,653	20,348	0	0	0
Fugitive Dust - Construction Activities	0	0	0	1,724	358	0	0	0
Windblown Dust	0	0	0	32,164	7,076	0	0	0
Fugitive Dust - Agricultural Tilling	0	0	0	31,668	7,021	0	0	0
Fugitive Dust - Cattle Feedlots	0	0	0	17	2	0	0	0
Fugitive Dust - Dairies	0	0	0	26	3	0	0	0
Architectural Surface Coating	3,503	0	0	0	0	0	0	0
Autobody Refinishing	523	0	0	0	0	0	0	1
Traffic Markings	623	0	0	0	0	0	0	0
Industrial Surface Coating	15,362	0	0	0	0	0	0	0
Solvent Cleaning/Degreasing	6,772	0	0	0	0	0	0	0
Dry Cleaning	2,313	0	0	0	0	0	0	0
Graphic Arts	1,762	0	0	0	0	0	0	0
Consumer and Commercial Solvent Use	8,499	0	0	0	0	0	0	0
Cutback Asphalt Paving	5	0	0	0	0	0	0	0
Gasoline Storage, Transport, and Distribution	11,103	0	0	0	0	0	0	0
Open Burning - Residential Yard Waste	208	0	1,117	244	244	0	0	0
Open Burning - Residential Household Waste	2,591	518	7,342	3,282	3,006	86	0	0
Wildfires	1,550	258	9,041	1,098	1,098	0	0	0
Prescribed Burning	17,558	5,853	196,066	27,508	27,508	0	0	0
Agricultural Burning	10,001	0	112,487	13,103	13,103	0	0	0
Structural Fires	23	3	125	23	23	0	0	0
Vehicle Fires	8	1	31	24	24	0	0	0
Livestock Ammonia	0	0	0	0	0	0	83,505	0
Fertilizer Ammonia	0	0	0	0	0	0	36,859	0
Domestic Ammonia	0	0	0	0	0	0	3,023	0
Charbroiling	0	0	0	654	654	0	0	0
Cold Storage Facilities	0	0	0	0	0	0	7,171	0
Bakeries	474	0	0	0	0	0	0	0
Miscellaneous Lead Area Sources	0	0	0	0	0	0	0	0
Grand Total	**89,543**	**26,699**	**351,460**	**281,667**	**91,547**	**27,223**	**130,773**	**1**

Table 5-2. AR 2002 Average Summer Weekday Area Source Emissions by Category in tons per day.

Category	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	SO_x	NH_3	Pb
Residential Wood Combustion	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA
Industrial Fuel Combustion - Natural Gas	0.78	39.84	11.95	1.08	1.08	0.09	0.46	NA
Industrial Fuel Combustion - LPG	0.09	5.31	0.90	0.16	0.16	0.00	0.00	NA
Industrial Fuel Combustion - Distillate Fuel	0.07	8.01	1.67	0.33	0.08	31.42	0.27	NA
Industrial Fuel Combustion - Residual Fuel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial Fuel Combustion - Coal	0.03	4.57	3.66	3.66	1.34	69.45	0.00	NA
Commercial Fuel Combustion - Natural Gas	0.07	1.21	1.02	0.09	0.09	0.01	0.01	NA
Commercial Fuel Combustion - LPG	0.00	0.11	0.01	0.00	0.00	0.00	0.00	NA
Commercial Fuel Combustion - Distillate Fuel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential Fuel Combustion - Natural Gas	0.12	2.02	0.86	0.16	0.16	0.01	0.01	NA
Residential Fuel Combustion - LPG	0.02	0.63	0.09	0.02	0.02	0.00	0.00	NA
Residential Fuel Combustion - Distillate Fuel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA
Residential Fuel Combustion - Kerosene	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA
Paved Roads	NA	NA	NA	99.36	24.84	NA	NA	NA
Unpaved Roads	NA	NA	NA	459.57	68.94	NA	NA	NA
Fugitive Dust - Construction Activities	NA	NA	NA	4.72	0.98	NA	NA	NA
Windblown Dust	NA	NA	NA	4.31	0.95	NA	NA	NA
Fugitive Dust - Agricultural Tilling	NA	NA	NA	9.49	2.10	NA	NA	NA
Fugitive Dust - Cattle Feedlots	NA	NA	NA	0.05	0.01	NA	NA	NA
Fugitive Dust - Dairies	NA	NA	NA	0.07	0.01	NA	NA	NA
Architectural Surface Coating	10.52	NA	NA	NA	NA	NA	NA	NA
Autobody Refinishing	2.00	NA	NA	NA	NA	NA	NA	0.00
Traffic Markings	3.21	NA	NA	NA	NA	NA	NA	NA
Industrial Surface Coating	58.86	NA	NA	NA	NA	NA	NA	NA
Solvent Cleaning/Degreasing	25.95	NA	NA	NA	NA	NA	NA	NA
Dry Cleaning	7.39	NA	NA	NA	NA	NA	NA	NA
Graphic Arts	5.06	NA	NA	NA	NA	NA	NA	NA
Consumer and Commercial Solvent Use	23.28	NA	NA	NA	NA	NA	NA	NA
Cutback Asphalt Paving	0.01	NA	NA	NA	NA	NA	NA	NA
Gasoline Storage, Transport, and Distribution	31.44	NA	NA	NA	NA	NA	NA	NA
Open Burning - Residential Yard Waste	0.57	0.00	3.06	0.67	0.67	0.00	NA	NA
Open Burning - Residential Household Waste	7.10	1.42	20.12	8.99	8.24	0.24	NA	NA
Wildfires	1.72	0.29	10.04	1.22	1.22	0.00	NA	NA
Prescribed Burning	18.30	6.10	204.29	28.66	28.66	0.00	NA	NA
Agricultural Burning	63.16	NA	752.46	90.72	90.72	NA	NA	NA
Structural Fires	0.06	0.01	0.33	0.06	0.06	NA	NA	NA
Vehicle Fires	0.02	0.00	0.08	0.07	0.07	NA	NA	NA
Livestock Ammonia	NA	NA	NA	NA	NA	NA	228.78	NA
Fertilizer Ammonia	NA	NA	NA	NA	NA	NA	64.59	NA
Domestic Ammonia	NA	NA	NA	NA	NA	NA	8.28	NA
Charbroiling	NA	NA	NA	1.79	1.79	NA	NA	NA
Cold Storage Facilities	NA	NA	NA	NA	NA	NA	19.65	NA
Bakeries	1.30	NA	NA	NA	NA	NA	NA	NA
Miscellaneous Lead Area Sources	NA	NA	NA	NA	NA	NA	NA	0.00
Grand Total	**261.13**	**69.51**	**1,010.54**	**715.26**	**232.19**	**101.22**	**322.04**	**0.00**

Table 5-3. AR 2002 Average Winter Weekday Area Source Emissions by Category in tons per day.

Category	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$	SO_x	NH_3	Pb
Residential Wood Combustion	44.80	1.63	131.25	18.02	18.02	0.25	NA	NA
Industrial Fuel Combustion - Natural Gas	0.78	39.84	11.95	1.08	1.08	0.09	0.46	NA
Industrial Fuel Combustion - LPG	0.09	5.31	0.90	0.16	0.16	0.00	0.00	NA
Industrial Fuel Combustion - Distillate Fuel	0.07	8.01	1.67	0.33	0.08	31.42	0.27	NA
Industrial Fuel Combustion - Residual Fuel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industrial Fuel Combustion - Coal	0.03	4.57	3.66	3.66	1.34	69.45	0.00	NA
Commercial Fuel Combustion - Natural Gas	0.55	9.97	8.38	0.76	0.76	0.06	0.05	NA
Commercial Fuel Combustion - LPG	0.02	0.88	0.12	0.03	0.03	0.00	0.00	NA
Commercial Fuel Combustion - Distillate Fuel	0.02	1.23	0.31	0.07	0.05	5.24	0.05	0.00
Residential Fuel Combustion - Natural Gas	0.64	10.98	4.67	0.89	0.89	0.07	0.06	NA
Residential Fuel Combustion - LPG	0.12	4.94	0.68	0.16	0.16	0.01	0.00	NA
Residential Fuel Combustion - Distillate Fuel	0.00	0.00	0.00	0.00	0.00	0.01	0.00	NA
Residential Fuel Combustion - Kerosene	0.00	0.07	0.02	0.00	0.00	0.02	0.00	NA
Paved Roads	NA	NA	NA	81.28	20.32	NA	NA	NA
Unpaved Roads	NA	NA	NA	359.27	53.89	NA	NA	NA
Fugitive Dust - Construction Activities	NA	NA	NA	4.72	0.98	NA	NA	NA
Windblown Dust	NA	NA	NA	136.78	30.09	NA	NA	NA
Fugitive Dust - Agricultural Tilling	NA	NA	NA	2.41	0.53	NA	NA	NA
Fugitive Dust - Cattle Feedlots	NA	NA	NA	0.05	0.01	NA	NA	NA
Fugitive Dust - Dairies	NA	NA	NA	0.07	0.01	NA	NA	NA
Architectural Surface Coating	8.70	NA	NA	NA	NA	NA	NA	NA
Autobody Refinishing	2.00	NA	NA	NA	NA	NA	NA	0.00
Traffic Markings	0.00	NA	NA	NA	NA	NA	NA	NA
Industrial Surface Coating	58.86	NA	NA	NA	NA	NA	NA	NA
Solvent Cleaning/Degreasing	25.95	NA	NA	NA	NA	NA	NA	NA
Dry Cleaning	7.39	NA	NA	NA	NA	NA	NA	NA
Graphic Arts	5.06	NA	NA	NA	NA	NA	NA	NA
Consumer and Commercial Solvent Use	23.28	NA	NA	NA	NA	NA	NA	NA
Cutback Asphalt Paving	0.01	NA	NA	NA	NA	NA	NA	NA
Gasoline Storage, Transport, and Distribution	30.42	NA	NA	NA	NA	NA	NA	NA
Open Burning - Residential Yard Waste	0.57	0.00	3.06	0.67	0.67	0.00	NA	NA
Open Burning - Residential Household Waste	7.10	1.42	20.12	8.99	8.24	0.24	NA	NA
Wildfires	3.74	0.62	21.80	2.65	2.65	0.00	NA	NA
Prescribed Burning	62.96	20.99	703.00	98.63	98.63	0.00	NA	NA
Agricultural Burning	0.00	0.00	0.00	0.00	0.00	0.00	NA	NA
Structural Fires	0.07	0.01	0.38	0.07	0.07	NA	NA	NA
Vehicle Fires	0.02	0.00	0.08	0.07	0.07	NA	NA	NA
Livestock Ammonia	NA	NA	NA	NA	NA	NA	228.78	NA
Fertilizer Ammonia	NA	NA	NA	NA	NA	NA	54.82	NA
Domestic Ammonia	NA	NA	NA	NA	NA	NA	8.28	NA
Charbroiling	NA	NA	NA	1.79	1.79	NA	NA	NA
Cold Storage Facilities	NA	NA	NA	NA	NA	NA	19.65	NA
Bakeries	1.30	NA	NA	NA	NA	NA	NA	NA
Miscellaneous Lead Area Sources	NA	NA	NA	NA	NA	NA	NA	0.00
Grand Total	**284.56**	**110.48**	**912.05**	**722.60**	**240.51**	**106.86**	**312.42**	**0.00**

Table 5-4. AR 2002 Annual Off-road Source Emissions by Category in tons per year.

Category	VOC	NOx	CO	PM10	PM2.5	SOx	NH3	Pb
Agricultural Equipment	2,282	13,785	18,649	1,875	1,725	2,019	8	0
Airport Ground Support Equipment	3	25	34	2	2	4	0	0
Commercial Equipment	1,847	1,056	39,872	109	100	115	1	0
Construction Equipment	1,540	8,567	13,974	875	805	1,430	6	0
Industrial Equipment	2,407	4,984	25,848	166	154	278	1	0
Lawn and Garden Equipment	4,395	575	69,599	120	110	46	2	0
Logging Equipment	234	428	1,618	43	39	83	0	0
Oil Field Equipment	37	28	349	1	1	3	0	0
Railroad Maintenance Equipment	8	33	95	5	5	5	0	0
Recreational Equipment	6,219	138	22,289	11	10	24	2	0
Recreational Marine Equipment	12,094	937	30,832	595	547	97	3	0
Underground Mining Equipment	0	0	0	0	0	0	0	0
Aircraft	855	835	9,380	197	182	76	0	5
Locomotives	1,123	26,452	2,929	736	677	1,814	13	0
Commercial Marine	215	8,893	1,501	239	220	888	6	0
Grand Total	**33,260**	**66,736**	**236,969**	**4,975**	**4,579**	**6,880**	**43**	**5**

Table 5-5. AR 2002 Average Summer Weekday Off-road Source Emissions by Category in tons per day.

Category	VOC	NOx	CO	PM10	PM2.5	SOx	NH3	Pb
Agricultural Equipment	9.77	59.26	81.51	8.07	7.42	8.69	0.04	0.00
Airport Ground Support Equipment	0.01	0.07	0.09	0.01	0.01	0.01	0.00	0.00
Commercial Equipment	5.76	3.21	131.10	0.35	0.32	0.36	0.00	0.00
Construction Equipment	6.42	35.85	59.65	3.67	3.37	5.99	0.02	0.00
Industrial Equipment	7.57	15.53	83.22	0.51	0.47	0.85	0.00	0.00
Lawn and Garden Equipment	14.11	1.87	238.57	0.40	0.37	0.17	0.01	0.00
Logging Equipment	0.74	1.35	5.25	0.14	0.12	0.26	0.00	0.00
Oil Field Equipment	0.11	0.08	1.11	0.00	0.00	0.01	0.00	0.00
Railroad Maintenance Equipment	0.03	0.11	0.34	0.02	0.02	0.02	0.00	0.00
Recreational Equipment	18.88	0.38	69.21	0.03	0.03	0.07	0.01	0.00
Recreational Marine Equipment	28.55	1.99	68.07	1.30	1.20	0.21	0.01	0.00
Underground Mining Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aircraft	3.03	2.93	29.32	0.61	0.57	0.26	0.00	0.01
Locomotives	3.05	71.88	7.96	2.00	1.84	4.93	0.03	0.00
Commercial Marine	0.58	24.17	4.08	0.65	0.60	2.41	0.02	0.00
Grand Total	**98.61**	**218.68**	**779.47**	**17.76**	**16.34**	**24.24**	**0.14**	**0.01**

Table 5-6. AR 2002 Average Winter Weekday Off-road Source Emissions by Category in tons per day.

Category	VOC	NOx	CO	PM10	PM2.5	SOx	NH3	Pb
Agricultural Equipment	1.82	10.75	14.20	1.46	1.34	1.57	0.01	0.00
Airport Ground Support Equipment	0.01	0.07	0.09	0.01	0.01	0.01	0.00	0.00
Commercial Equipment	6.04	3.57	125.34	0.35	0.32	0.37	0.00	0.00
Construction Equipment	4.04	22.38	35.71	2.28	2.10	3.73	0.02	0.00
Industrial Equipment	7.81	16.09	82.51	0.52	0.48	0.86	0.00	0.00
Lawn and Garden Equipment	4.52	0.44	43.83	0.15	0.14	0.03	0.00	0.00
Logging Equipment	0.76	1.39	5.13	0.14	0.13	0.27	0.00	0.00
Oil Field Equipment	0.11	0.08	0.95	0.00	0.00	0.01	0.00	0.00
Railroad Maintenance Equipment	0.03	0.12	0.33	0.02	0.02	0.02	0.00	0.00
Recreational Equipment	8.19	0.21	28.02	0.01	0.01	0.03	0.00	0.00
Recreational Marine Equipment	7.40	0.33	9.81	0.19	0.18	0.03	0.00	0.00
Underground Mining Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aircraft	1.70	1.72	21.76	0.46	0.42	0.16	0.00	0.01
Locomotives	3.08	72.67	8.05	2.02	1.86	4.98	0.03	0.00
Commercial Marine	0.59	24.43	4.12	0.66	0.61	2.44	0.02	0.00
Grand Total	**46.10**	**154.23**	**379.86**	**8.27**	**7.62**	**14.52**	**0.09**	**0.01**

Table 5-7. AR 2002 Annual Onroad Source Emissions by Vehicle Class in tons per year.

Category	Category - short name	VOC	NOx	CO	PM10	PM2.5	SOx	NH3
Light Duty Gasoline Vehicle	LDGV	33,406	24,636	395,606	437	233	1,013	1,475
Light Duty Gasoline Truck 1&2	LDGT12	21,507	16,627	300,173	314	177	856	964
Light Duty Gasoline Truck 3&4	LDGT34	9,284	7,266	131,983	154	89	461	393
Heavy Duty Gasoline Vehicle	HDGV	3,150	6,111	41,664	136	97	194	51
Light Duty Diesel Vehicle	LDDV	34	66	72	12	11	4	0
Light Duty Diesel Truck	LDDT	69	115	120	16	14	14	0
Heavy Duty Diesel Vehicle	HDDV	2,068	40,529	10,860	1,491	1,319	1,247	70
Motor Cycle	MC	437	283	2,893	8	4	7	2
Total	**Total**	**69,955**	**95,632**	**883,371**	**2,567**	**1,943**	**3,795**	**2,955**

Table 5-8. AR 2002 Average Summer Weekday Onroad Source Emissions by Vehicle Class in tons per day.

Category	VOC	NOx	CO	PM10	PM2.5	SOx	NH3
Light Duty Gasoline Vehicle	91.98	59.32	973.88	1.28	0.68	2.96	4.31
Light Duty Gasoline Truck 1&2	58.38	39.31	715.55	0.92	0.52	2.50	2.82
Light Duty Gasoline Truck 3&4	25.74	17.03	342.22	0.45	0.26	1.35	1.15
Heavy Duty Gasoline Vehicle	9.47	17.59	125.60	0.40	0.28	0.57	0.15
Light Duty Diesel Vehicle	0.10	0.19	0.21	0.03	0.03	0.01	0.00
Light Duty Diesel Truck	0.20	0.34	0.35	0.05	0.04	0.04	0.00
Heavy Duty Diesel Vehicle	6.00	118.53	31.50	4.35	3.85	3.65	0.20
Motor Cycle	1.33	0.60	9.14	0.02	0.01	0.02	0.01
Grand Total	**193.21**	**252.92**	**2198.45**	**7.49**	**5.67**	**11.10**	**8.64**

Table 5-9. AR 2002 Average Winter Weekday Onroad Source Emissions by Vehicle Class in tons per day.

Category	VOC	NOx	CO	PM10	PM2.5	SOx	NH3
Light Duty Gasoline Vehicle	94.97	78.83	1320.00	1.17	0.63	2.72	3.97
Light Duty Gasoline Truck 1&2	62.54	53.58	1010.79	0.85	0.48	2.30	2.59
Light Duty Gasoline Truck 3&4	26.60	23.42	422.57	0.41	0.24	1.24	1.06
Heavy Duty Gasoline Vehicle	8.04	16.86	115.39	0.37	0.26	0.52	0.14
Light Duty Diesel Vehicle	0.09	0.18	0.19	0.03	0.03	0.01	0.00
Light Duty Diesel Truck	0.19	0.31	0.32	0.04	0.04	0.04	0.00
Heavy Duty Diesel Vehicle	5.61	109.23	29.54	4.02	3.56	3.35	0.19
Motor Cycle	1.09	0.95	7.87	0.02	0.01	0.02	0.01
Grand Total	**199.13**	**283.36**	**2906.68**	**6.92**	**5.24**	**10.21**	**7.94**

Table 5-10. Land use categories and codes utilized in the NLCD.

NLCD Category Code	NLCD Category Description
11	Open Water
12	Perennial Ice/Snow
21	Low Intensity Residential
22	High Intensity Residential
23	Commercial/Industrial/Transportation
31	Bare Rock/Sand/Clay
32	Quarries/Strip Mines/Gravel Pits
33	Transitional
41	Deciduous Forest
42	Evergreen Forest
43	Mixed Forest
51	Shrubland
61	Orchards/Vineyards/Other
71	Grasslands/Herbaceous
81	Pasture/Hay
82	Row Crops
83	Small Grains
84	Fallow
85	Urban/Recreational Grasses
91	Woody Wetlands
92	Emergent Herbaceous Wetlands

Table 5-11. Mapping of EPS2 surrogate codes to NLCD LULC codes.

Surrogate Name	EPS2 Surrogate Code	NLCD LULC Codes
Population	1	2000 US Census (EPA Surrogate Database)
Households	2	2000 US Census (EPA Surrogate Database)
County area	3	Sum all LULC codes
Residential	4	Sum LULC codes 21 and 22
Commercial/Industrial	5	Sum LULC codes 22, 23 and 85
Agricultural	6	Sum LULC codes 61 and 81-84
Range	7	Sum LULC codes 51 and 71
Forest	8	Sum LULC code 41-43
Bodies of Water	9	Sum LULC codes 11 and 12
Barren	10	Sum LULC codes 31-33
Commercial/Industrial /Transportation	11	LULC code 23
Rural	12	Sum LULC codes 31-33, 41-43, 51, 61, 71, 81-84 and 91-92
Ports	13	Ports from EPA's surrogate database
Airports	14	Airports from EPA's surrogate database
Urban primary roads	15	Urban primary roads from EPA's surrogate database
Rural primary roads	16	Rural primary roads from EPA's surrogate database
Urban secondary roads	17	Urban secondary roads from EPA's surrogate database
Rural secondary roads	18	Rural secondary roads from EPA's surrogate database
All roads	19	All roads from EPA's surrogate database
Rural	20	Sum LULC codes 31-33, 41-43, 51, 61, 71, 81-84 and 91-92

Table 5-12. Source category codes and spatial surrogate assignments.

Source Category	Gridding Surrogate Code	SCC	Surrogate Description
Area			
Other Fuel Combustion (Industrial Coal)	5	2102002000	Urban Commercial/Industrial Land
Other Fuel Combustion (Industrial Distillate)	5	2102004000	Urban Commercial/Industrial Land
Other Fuel Combustion (Industrial Residual)	5	2102005000	Urban Commercial/Industrial Land
Other Fuel Combustion (Industrial Natural Gas)	5	2102006000	Urban Commercial/Industrial Land
Other Fuel Combustion (Industrial Propane)	5	2102007000	Urban Commercial/Industrial Land
Other Fuel Combustion (Industrial Kerosene)	5	2102011000	Urban Commercial/Industrial Land
Other Fuel Combustion (Comm/Inst Coal)	5	2103002000	Urban Commercial/Industrial Land
Other Fuel Combustion (Comm/Inst Distillate)	5	2103004000	Urban Commercial/Industrial Land
Other Fuel Combustion (Comm/Inst Residual)	5	2103005000	Urban Commercial/Industrial Land
Other Fuel Combustion (Comm/Inst Natural Gas)	5	2103006000	Urban Commercial/Industrial Land
Other Fuel Combustion (Comm/Inst Propane)	5	2103007000	Urban Commercial/Industrial Land
Other Fuel Combustion (Comm/Inst Kerosene)	5	2103011000	Urban Commercial/Industrial Land
Other Fuel Combustion (Residential Coal)	2	2104002000	Housing
Other Fuel Combustion (Residential Distillate)	2	2104004000	Housing
Other Fuel Combustion (Residential Residual)	2	2104005000	Housing
Other Fuel Combustion (Residential Natural Gas)	2	2104006000	Housing
Other Fuel Combustion (Residential Propane)	2	2104007000	Housing
Residential Wood Combustion (Fireplaces)	2	2104008001	Housing
Residential Wood Combustion (Woodstoves)	2	2104008010	Housing
Other Fuel Combustion (Residential Kerosene)	2	2104011000	Housing
Paved Road Fugitive Dust	19	2294000000	All roads
Unpaved Road Fugitive Dust	12	2296000000	Rural Land
Cold Storage Ammonia	9	2302080002	Water
Construction Activities	1	2311000000	Population
Mining and Quarrying	10	2325000000	Barren
Architectural Surface Coating	2	2401001000	Housing
Autobody Refinishing	5	2401005000	Urban Commercial/Industrial Land
Traffic Markings	19	2401008000	All roads
Surface Coating (Factory Finished Wood)	5	2401015000	Urban Commercial/Industrial Land
Surface Coating (Furniture)	5	2401020000	Urban Commercial/Industrial Land
Surface Coating (Metal Cans)	5	2401040000	Urban Commercial/Industrial Land
Surface Coating (Misc. Finished Metals)	5	2401050000	Urban Commercial/Industrial Land
Surface Coating (Machinery and Equipment)	5	2401055000	Urban Commercial/Industrial Land
Surface Coating (Appliances)	5	2401060000	Urban Commercial/Industrial Land
Surface Coating (Electronic/Electrical)	5	2401065000	Urban Commercial/Industrial Land
Surface Coating (Motor Vehicles)	5	2401070000	Urban Commercial/Industrial Land
Surface Coating (Marine)	5	2401080000	Urban Commercial/Industrial Land
Surface Coating (Railroad)	5	2401085000	Urban Commercial/Industrial Land
Surface Coating (Misc. Manufacturing)	5	2401090000	Urban Commercial/Industrial Land
Surface Coating (High Perf. Ind. Maint. Coatings)	5	2401100000	Urban Commercial/Industrial Land
Surface Coating (Other Special Purpose Coatings)	5	2401200000	Urban Commercial/Industrial Land
Solvent Degreasing (Vapor and In-Line Cleaning - Electronics and Electrical)	5	2415230000	Urban Commercial/Industrial Land
Solvent Degreasing (Vapor and In-Line Cleaning - Other)	5	2415245000	Urban Commercial/Industrial Land
Solvent Degreasing (Cold Cleaning - Manufacturing)	5	2415345000	Urban Commercial/Industrial Land
Solvent Degreasing (Cold Cleaning - Automobile Repair)	5	2415360000	Urban Commercial/Industrial Land
Dry Cleaning	5	2420000000	Urban Commercial/Industrial Land
Graphic Arts	5	2425000000	Urban Commercial/Industrial Land
Consumer Solvent Use	2	2460000000	Housing
Asphalt Paving	19	2461020000	All roads
Pesticides	6	2461850000	Agricultural
Gasoline Distribution (Stage I)	5	2501060050	Urban Commercial/Industrial Land
Gasoline Distribution (Stage II)	5	2501060100	Urban Commercial/Industrial Land

Source Category	Gridding Surrogate Code	SCC	Surrogate Description
Gasoline Distribution (Underground Tank)	5	2501060200	Urban Commercial/Industrial Land
Gasoline Distribution (Tank Truck Transit)	5	2505030120	Urban Commercial/Industrial Land
Open Burning (Residential Yard Waste)	2	2610000100	Housing
Open Burning (Residential MSW)	2	2610030000	Housing
Agricultural Windblown Dust	6	2730100000	Agricultural
Agricultural Tillage	6	2801000003	Agricultural
Agricultural Burning	6	2801500000	Agricultural
Fertilizer Application	6	2801700000	Agricultural
Livestock Ammonia	6	2805000000	Agricultural
Wildfires	8	2810001000	Forest
Prescribed Fires	8	2810015000	Forest
Charbroiling	5	2810025000	Urban Commercial/Industrial Land
Structural Fires	2	2810030000	Housing
Vehicle Fires	1	2810050000	Population
commercial charbroiling	5	2302002000	Urban Commercial/Industrial Land
cutback asphalt commercial	5	2461021000	Urban Commercial/Industrial Land
domestic ammonia aggregated	2	2806020000	Housing
industrial bakery	5	2302050000	Urban Commercial/Industrial Land
industrial surface coatings aggregated	5	2401300000	Urban Commercial/Industrial Land
miscellaneous lead aggregated	3	2999999999	County Area
open burning yard waste aggregated	2	2610000050	Housing
solvent utilization	5	2415000000	Urban Commercial/Industrial Land
gas service stations	5	2501060000	Urban Commercial/Industrial Land
residential wood combustion	2	2104008000	Housing
Off-Road Mobile			
Agricultural Equipment	6	2200005000	Agricultural
Aircraft	14	2275000000	Airports
Aircraft	14	2275075000	Airports
Airport Equipment	14	2200008000	Airports
gse	14	2200008005	Airports
Commercial Equipment	5	2200006000	Urban Commercial/Industrial Land
underground mining equipment	10	2200009000	Barren
Commercial Marine	9	2280002000	Water
Construction and Mining Equipment	1	2200002000	Population
Industrial Equipment	5	2200003000	Urban Commercial/Industrial Land
Lawn and Garden Equipment	2	2200004000	Housing
Locomotives	20	2285002005	Railways
Logging Equipment	8	2200007000	Forest
oil field equipment	12	2200010000	Rural Land
Pleasure Craft	9	2282000000	Water
recreational marine equipment	9	2282010005	Water
Railroad Equipment	20	2285000015	Railways
Railroad Equipment	20	2285004000	Railways
Railroad maintenance Equipment	20	2285004015	Railways
Recreational Equipment	12	2200001000	Rural Land
On-Road Mobile			
All on-road mobile sources	19	22xxxxxxxx	All roads

Figure 5-1.
Arkansas 2002 Annual VOC Emissions from Area Sources

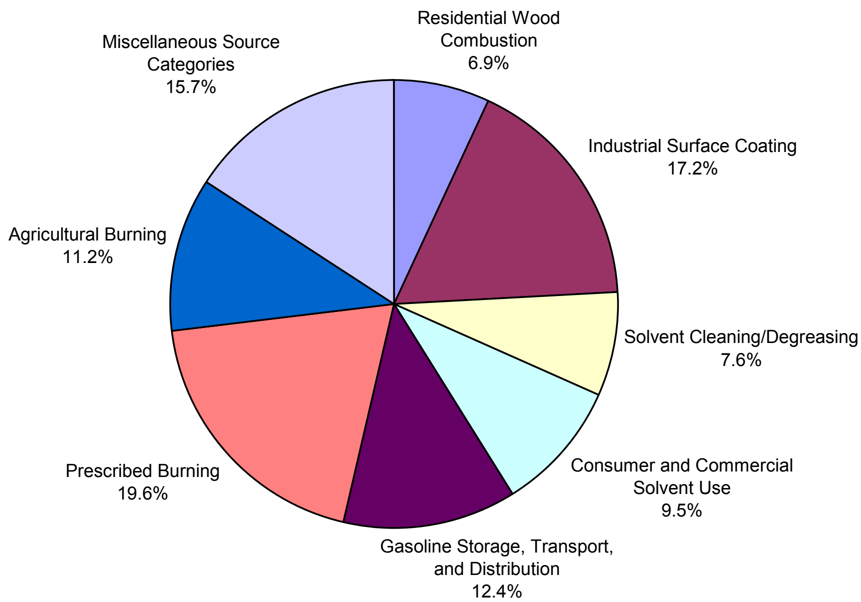


Figure 5-2.
Arkansas 2002 Annual NO_x Emissions from Area Sources

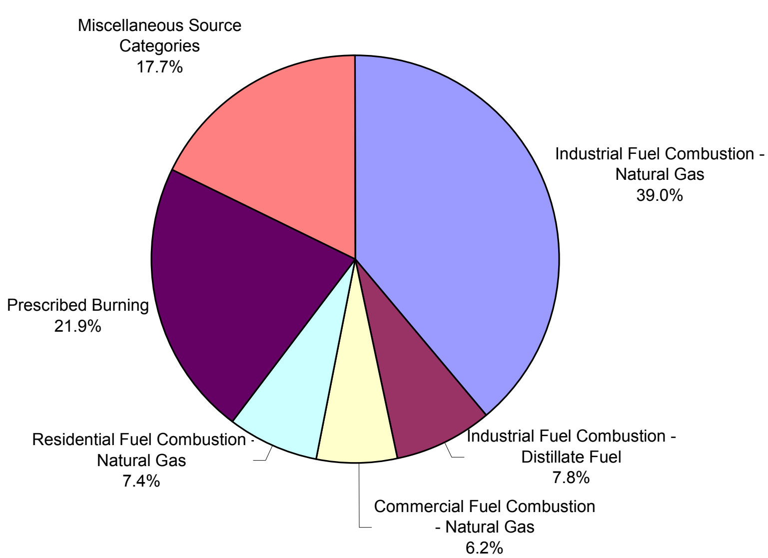


Figure 5-3.
Arkansas 2002 Annual CO Emissions from Area Sources

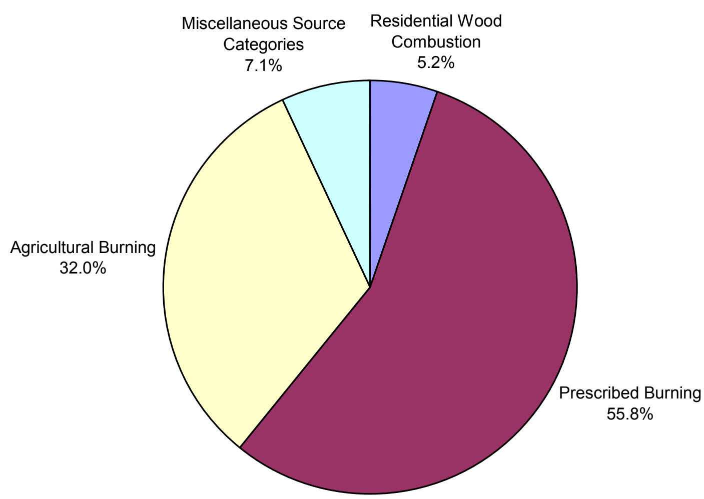


Figure 5-4.
Arkansas 2002 Annual PM_{10} Emissions from Area Sources

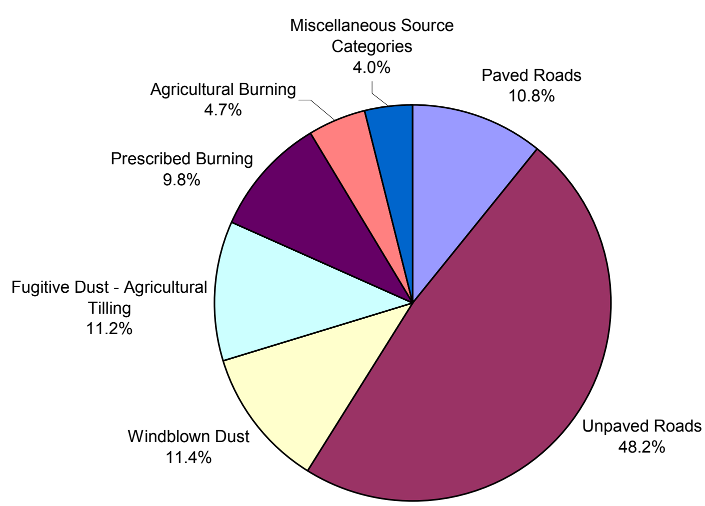


Figure 5-5.
Arkansas 2002 Annual $PM_{2.5}$ Emissions from Area Sources

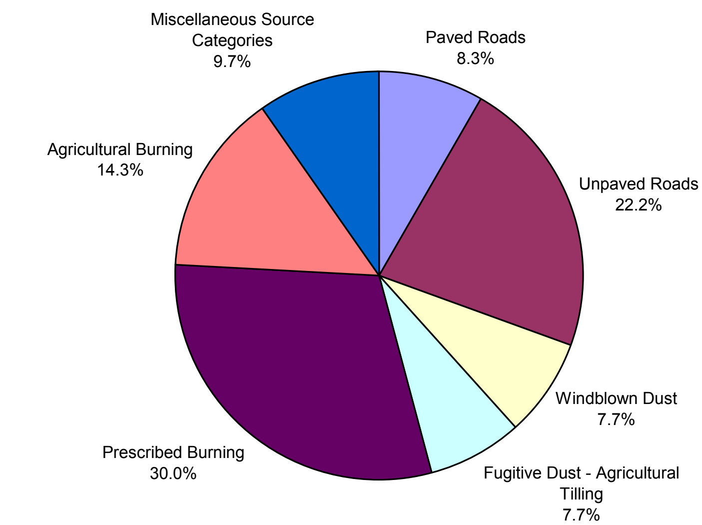


Figure 5-6.
Arkansas 2002 Annual SO_x Emissions from Area Sources

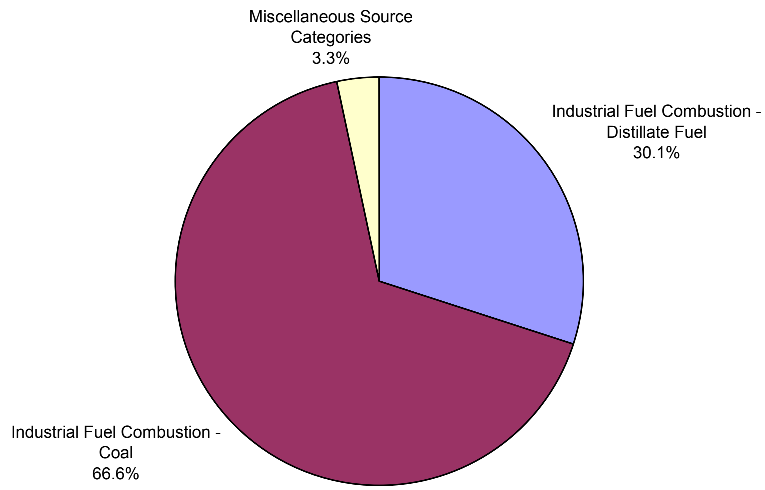


Figure 5-7.
Arkansas 2002 Annual NH_3 Emissions from Area Sources

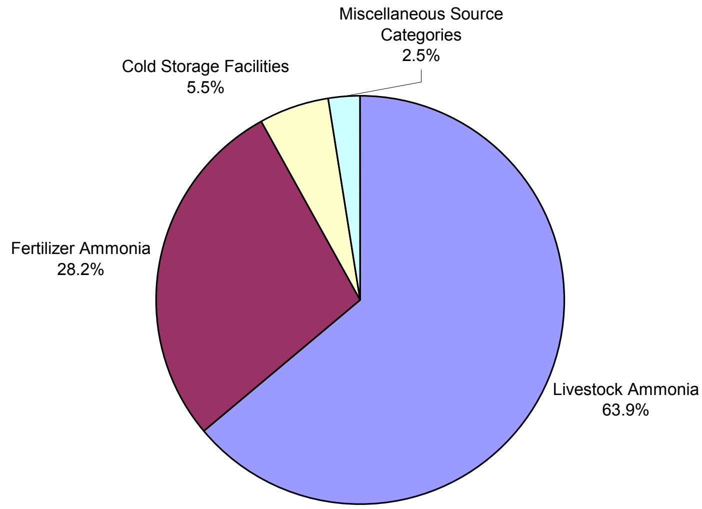


Figure 5-8.
Arkansas 2002 VOC Emissions from Off-Road Mobile Sources

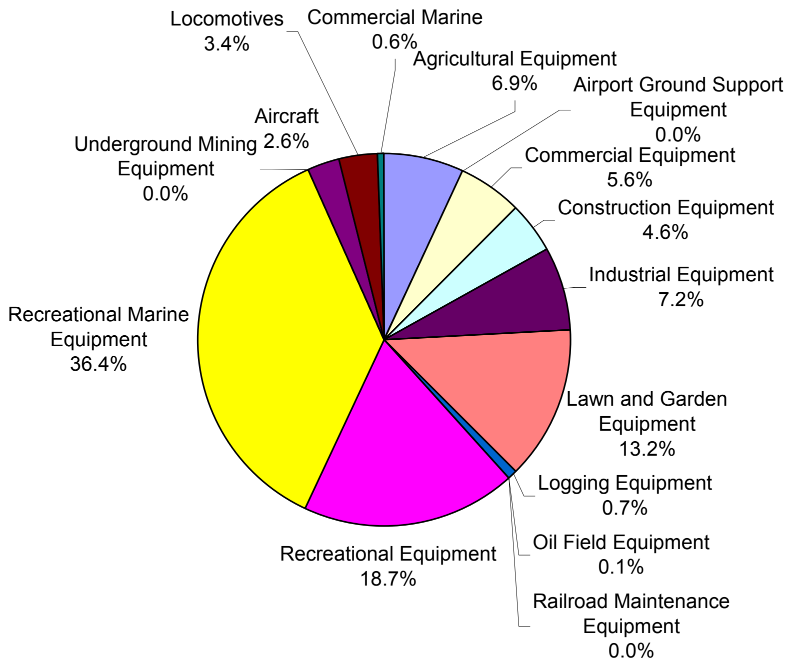


Figure 5-9.
Arkansas 2002 NOx Emissions from Off-Road Mobile Sources

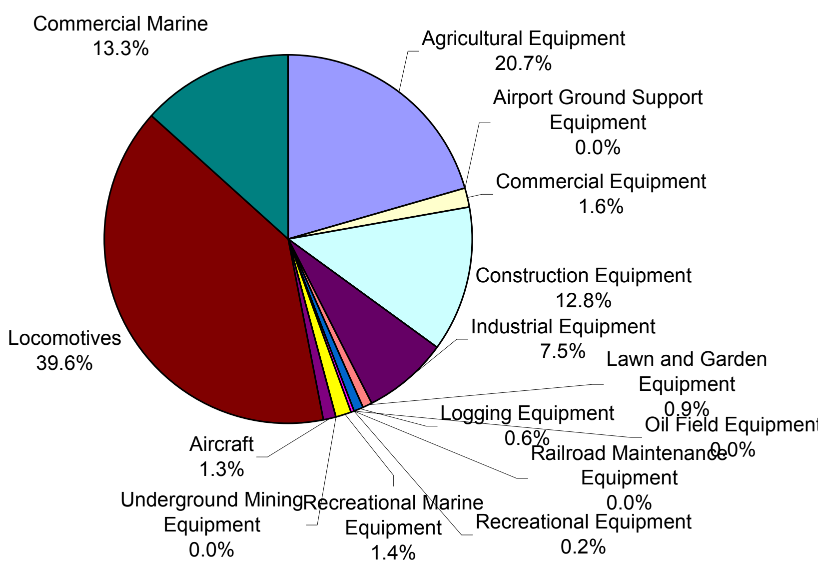


Figure 5-10.
Arkansas 2002 CO Emissions from Off-Road Mobile Sources

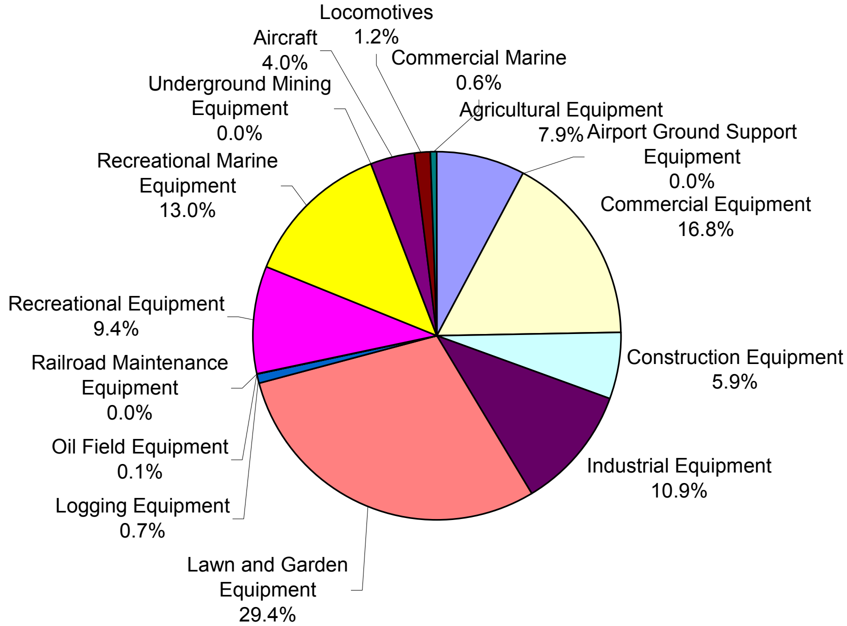


Figure 5-11.
Arkansas 2002 PM_{10} Emissions from Off-Road Mobile Sources

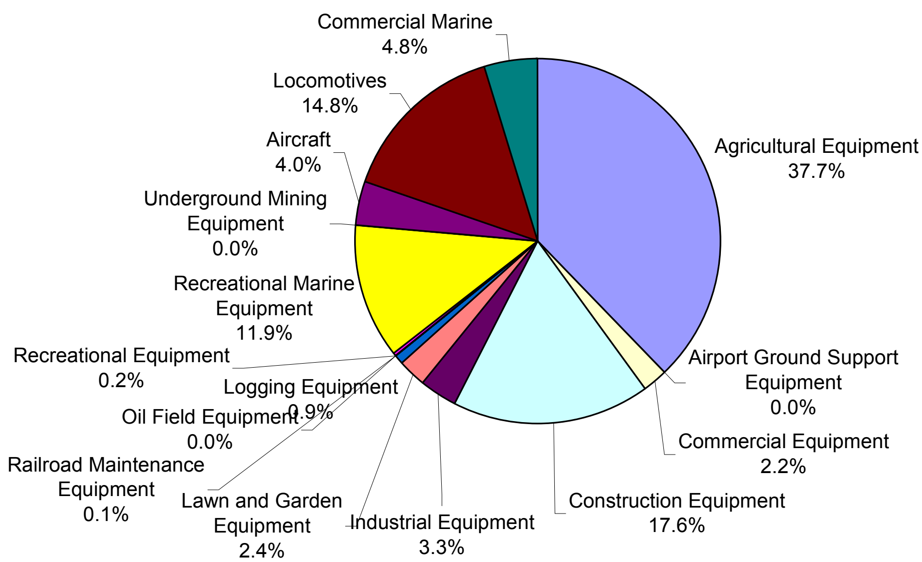


Figure 5-12.
Arkansas 2002 $PM_{2.5}$ Emissions from Off-Road Mobile Sources

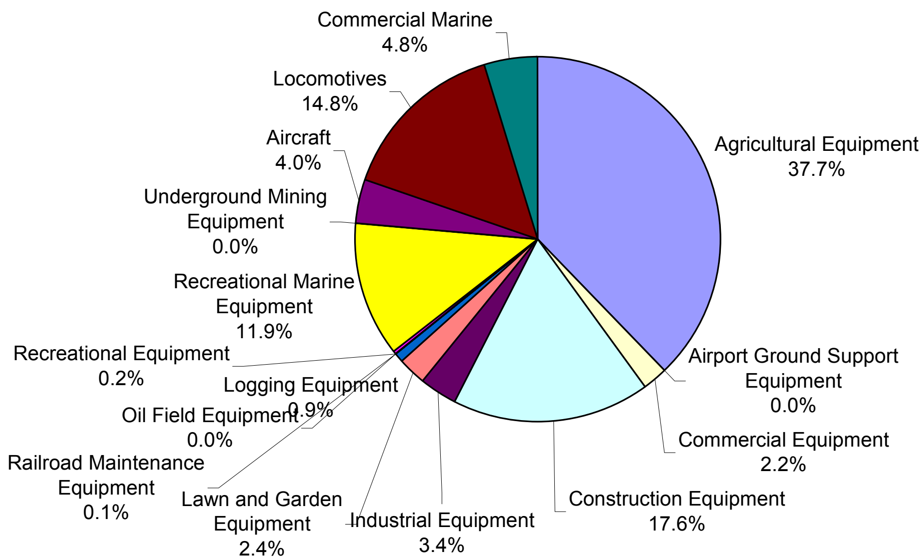


Figure 5-13.
Arkansas 2002 SOx Emissions from Off-Road Mobile Sources

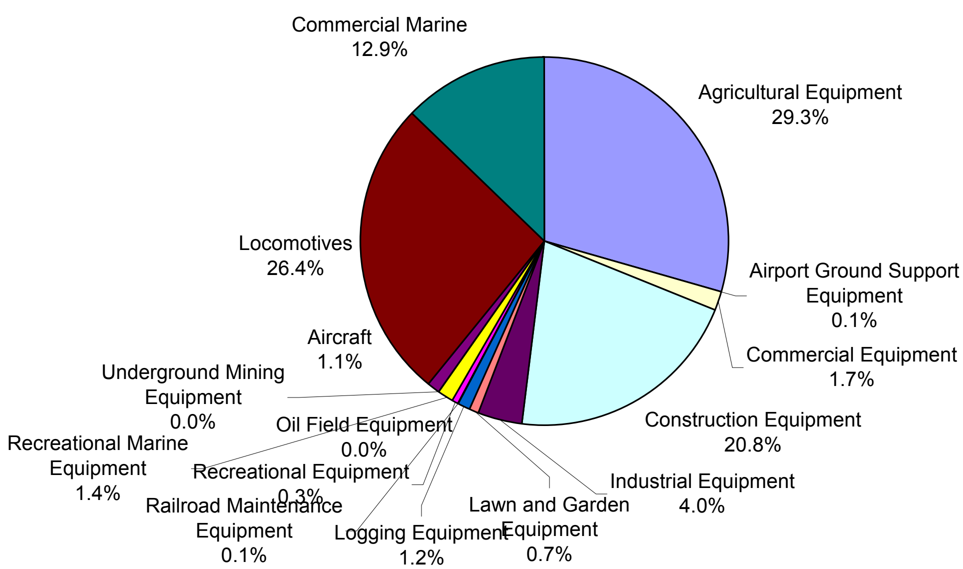


Figure 5-14.
Arkansas 2002 NH_3 Emissions from Off-Road Mobile Sources

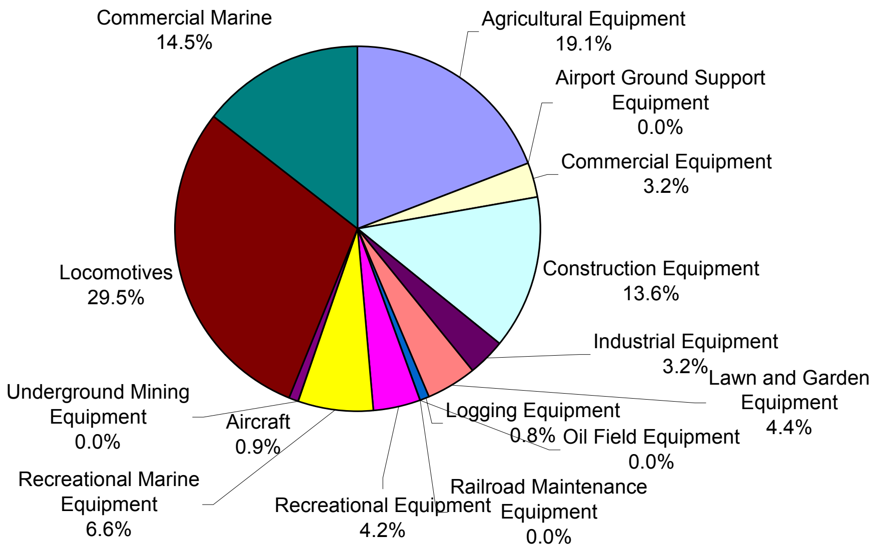


Figure 5-15.
Arkansas 2002 VOC Emissions from On-Road Mobile Sources

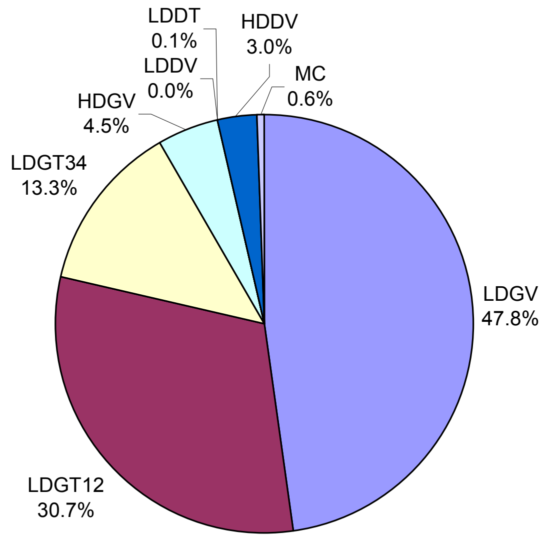


Figure 5-16.
Arkansas 2002 NOx Emissions from On-Road Mobile Sources

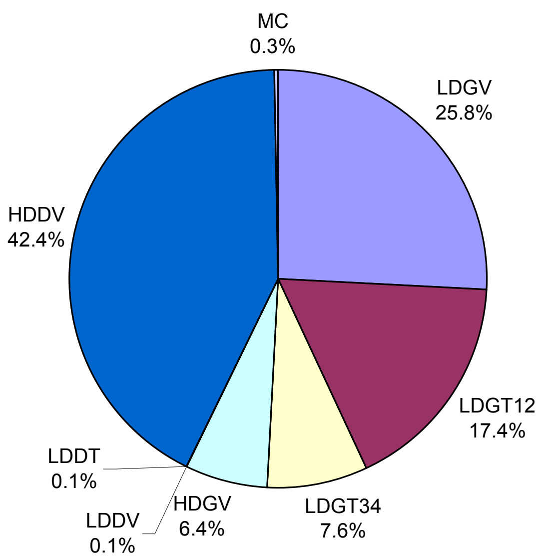


Figure 5-17.
Arkansas 2002 CO Emissions from On-Road Mobile Sources

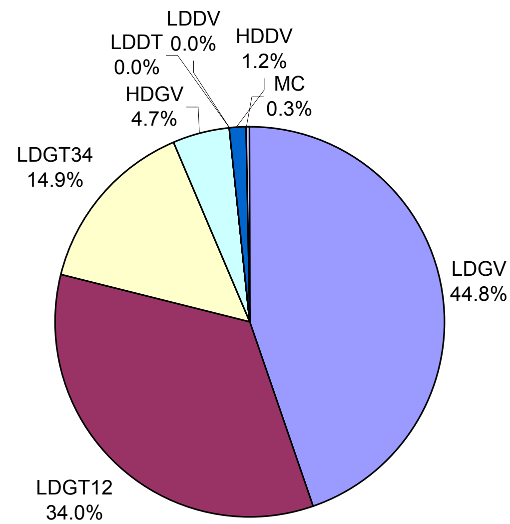


Figure 5-18.
Arkansas 2002 PM_{10} Emissions from On-Road Mobile Sources

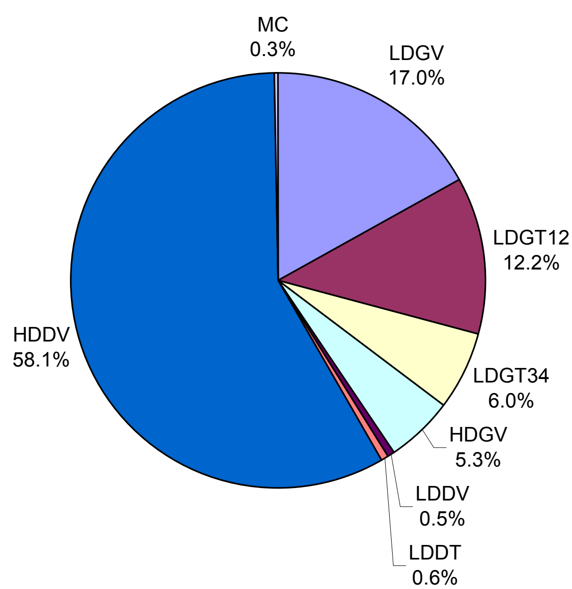


Figure 5-19.
Arkansas 2002 $PM_{2.5}$ Emissions from On-Road Mobile Sources

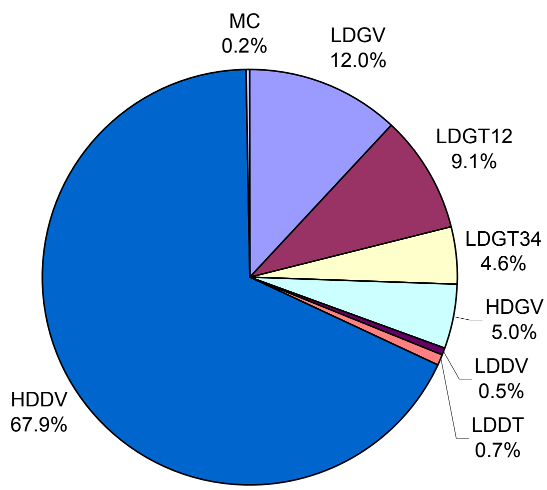


Figure 5-20.
Arkansas 2002 SOx Emissions from On-Road Mobile Sources

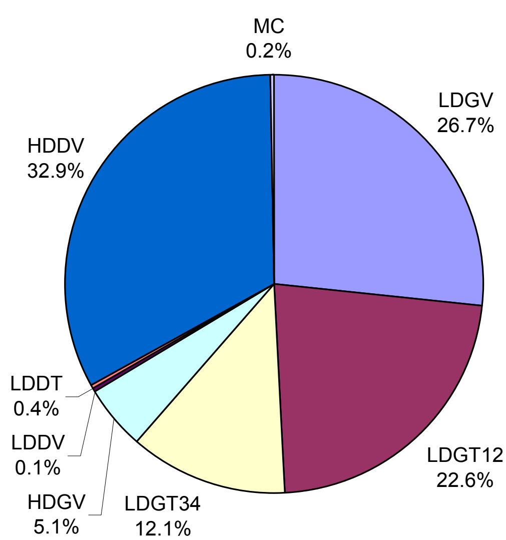


Figure 5-21.
Arkansas 2002 NH_3 Emissions from On-Road Mobile Sources

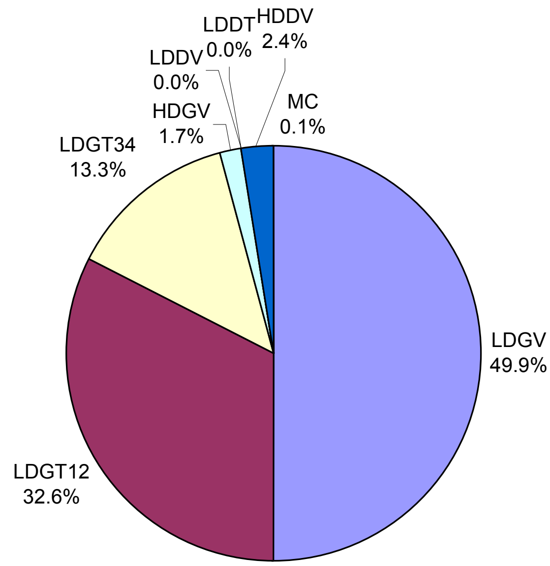


Figure 5-22
Residential land surrogate

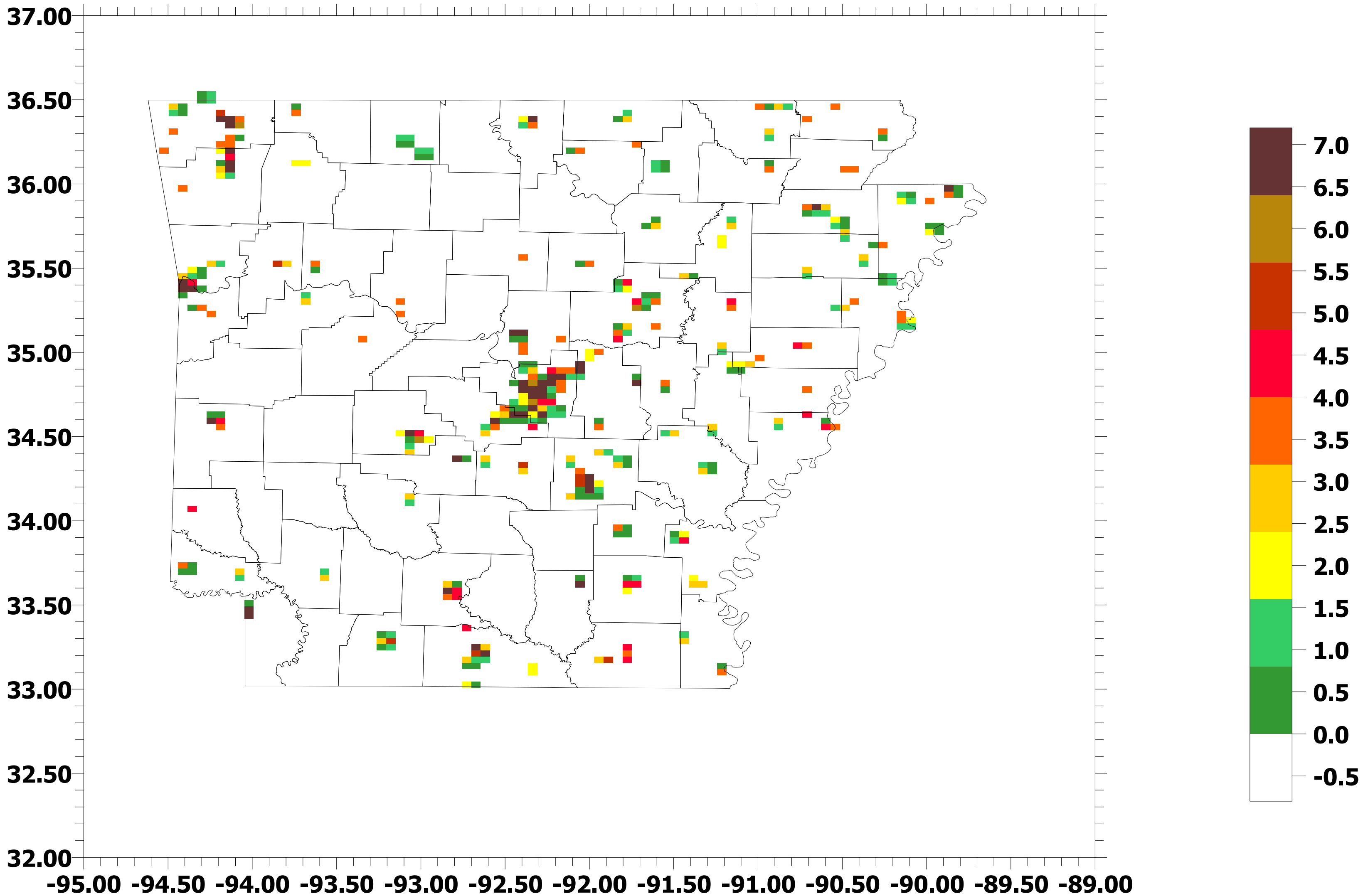


Figure 5-23

Agricultural land surrogate

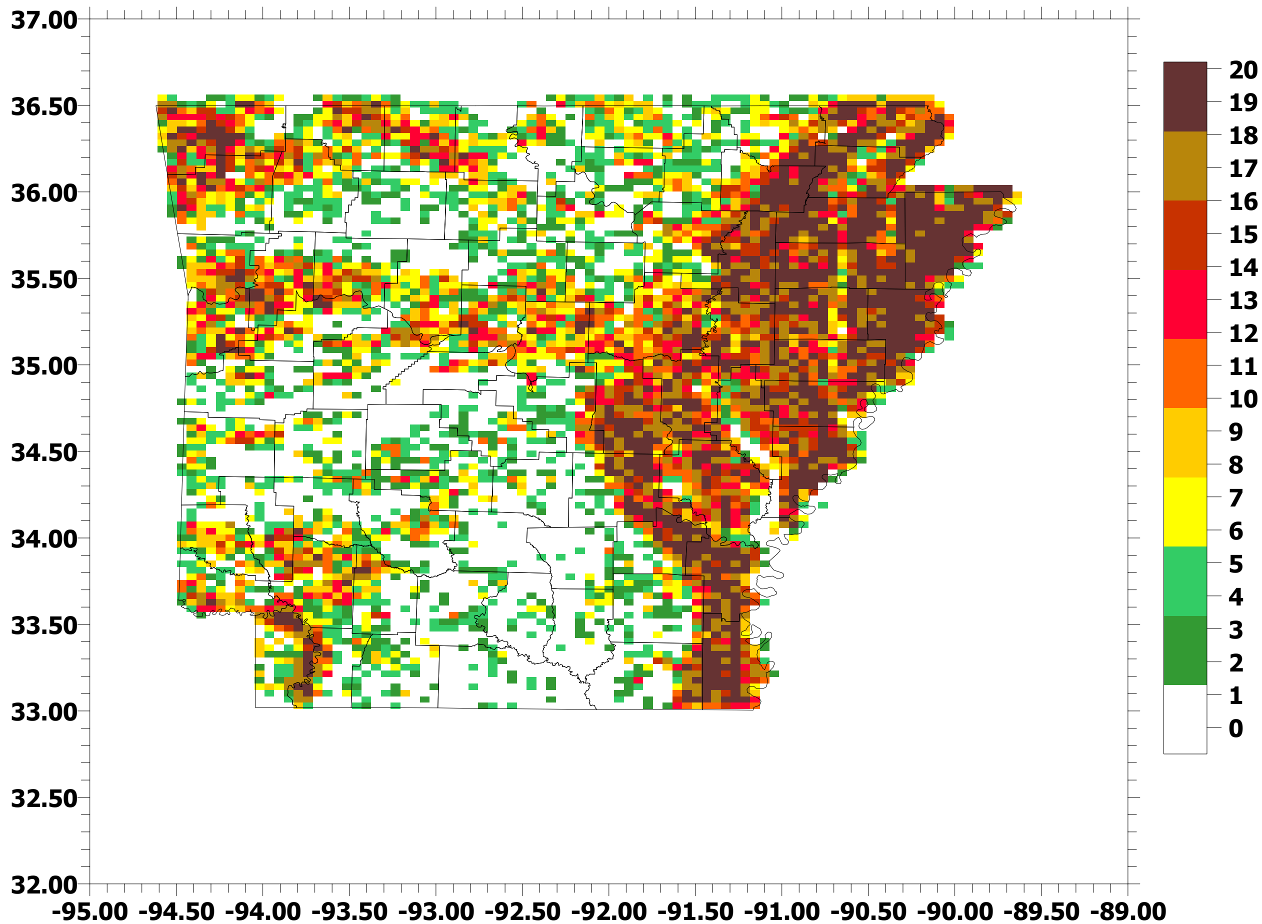
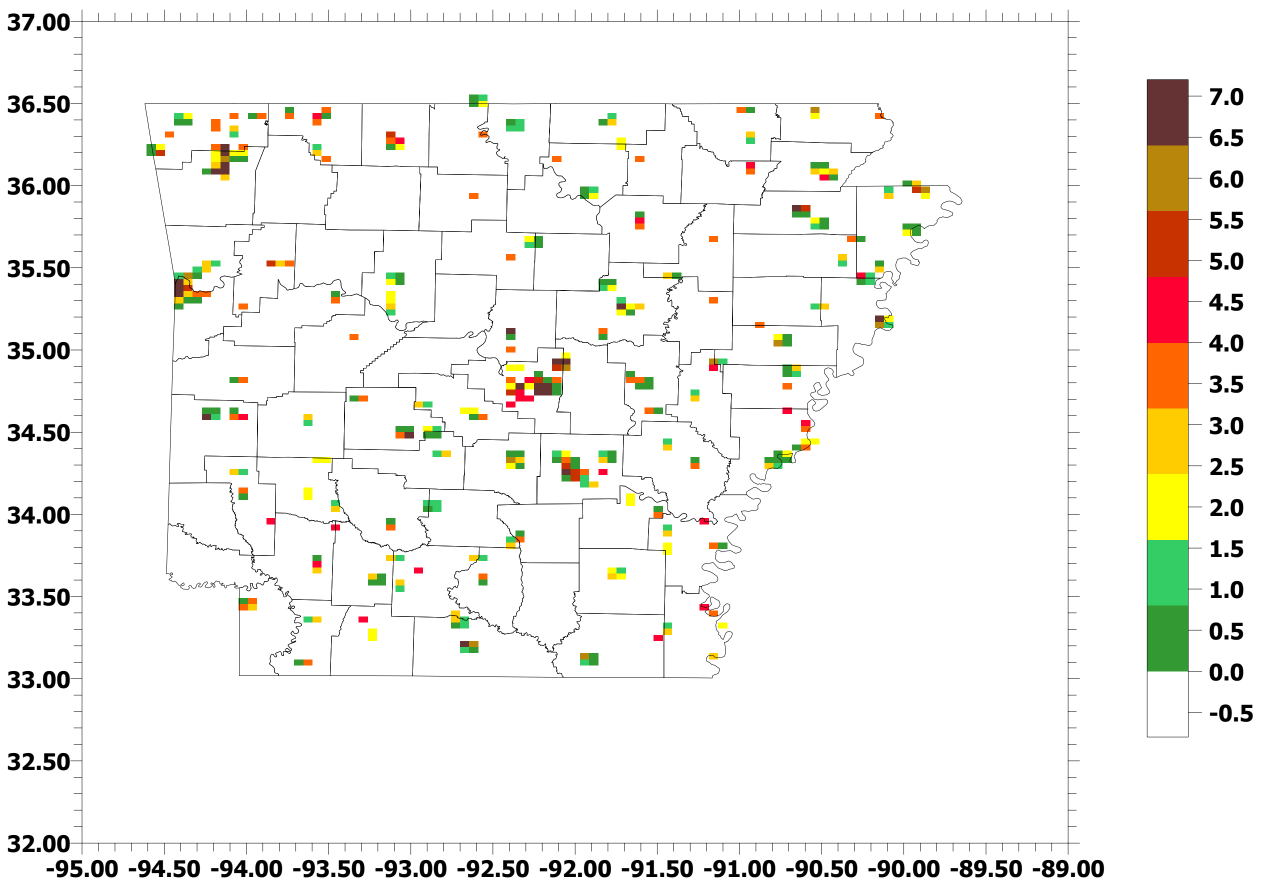


Figure 5-24
Industrial/Commercial land surrogate



ENVIRON

Figure 5-25.

Arkansas Area Sources Summer Weekday VOC Emissions (tpd)

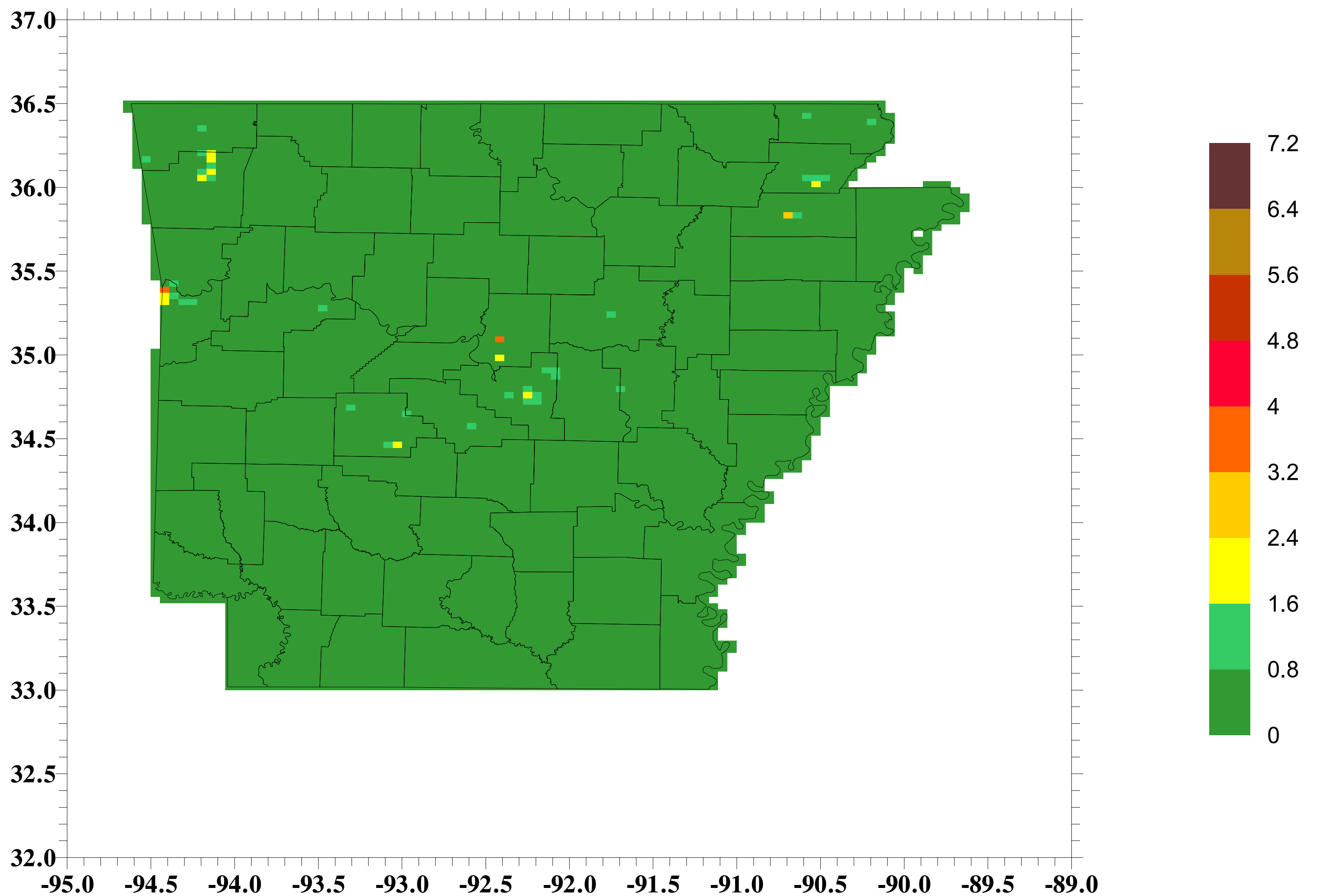


Figure 5-26.

Arkansas Area Sources Summer Weekday NOx Emissions (tpd)

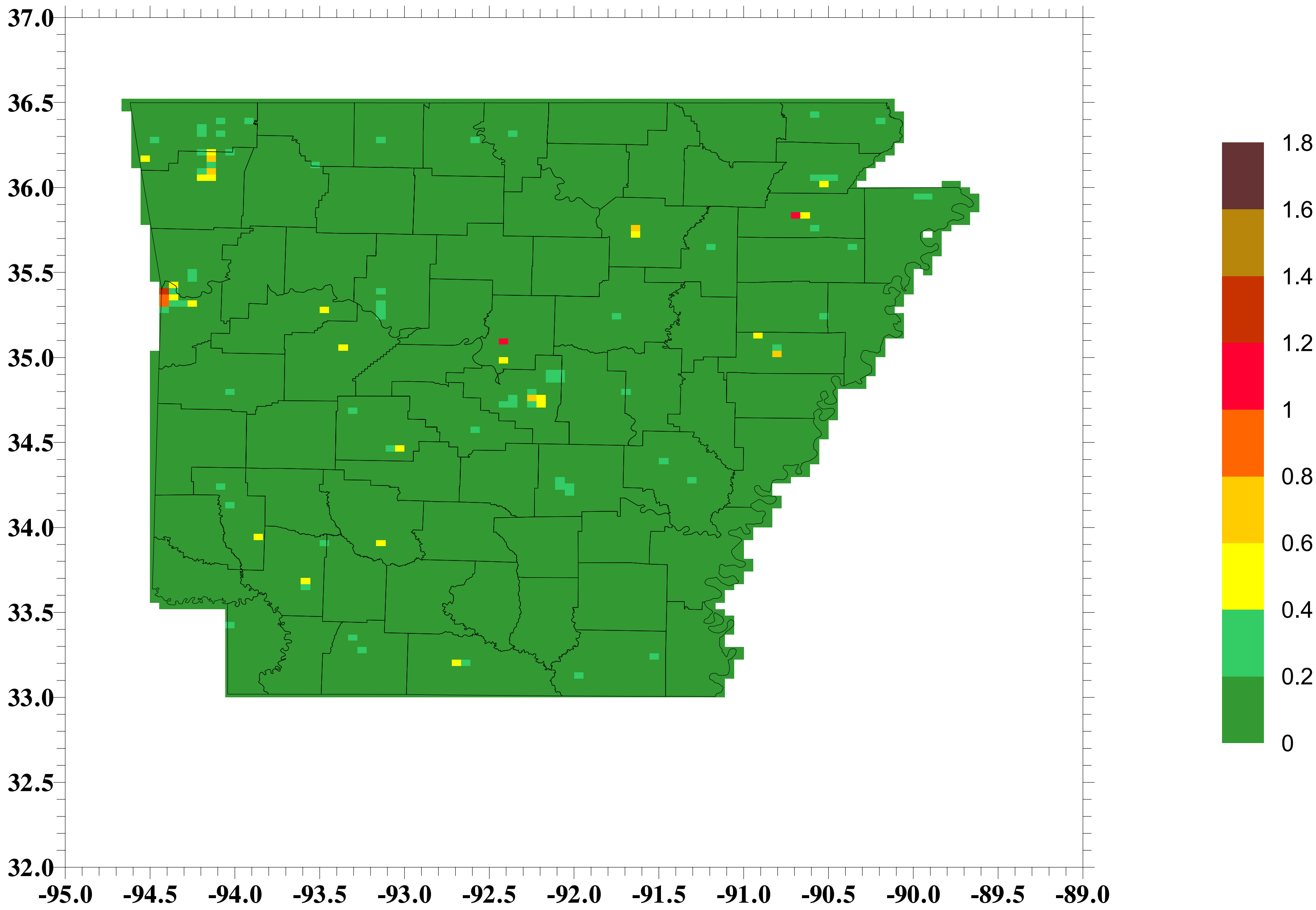


Figure 5-27.

Arkansas Area Sources Summer Weekday CO Emissions (tpd)

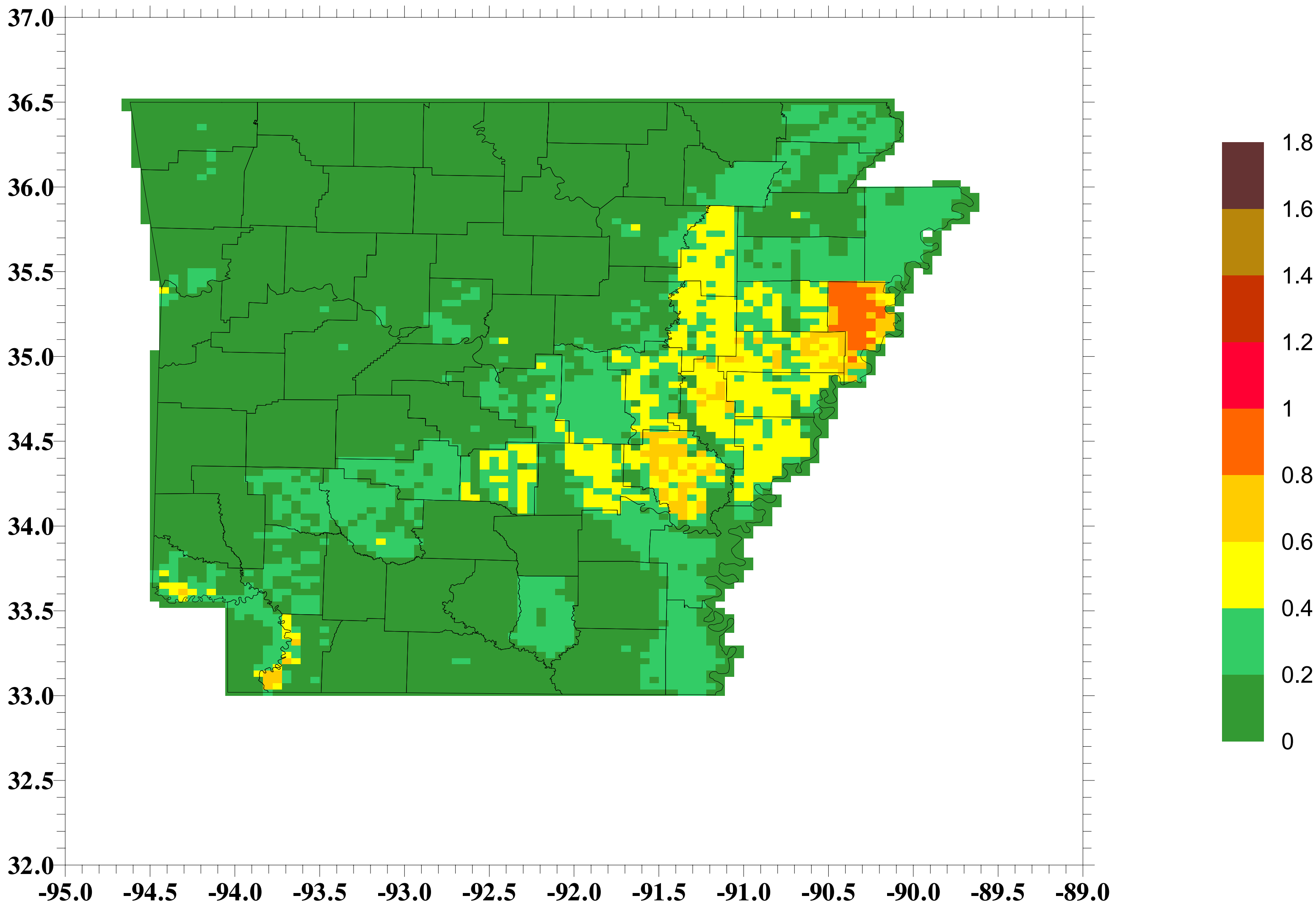


Figure 5-28.

Arkansas Area Sources Summer Weekday PM10 Emissions (tpd)

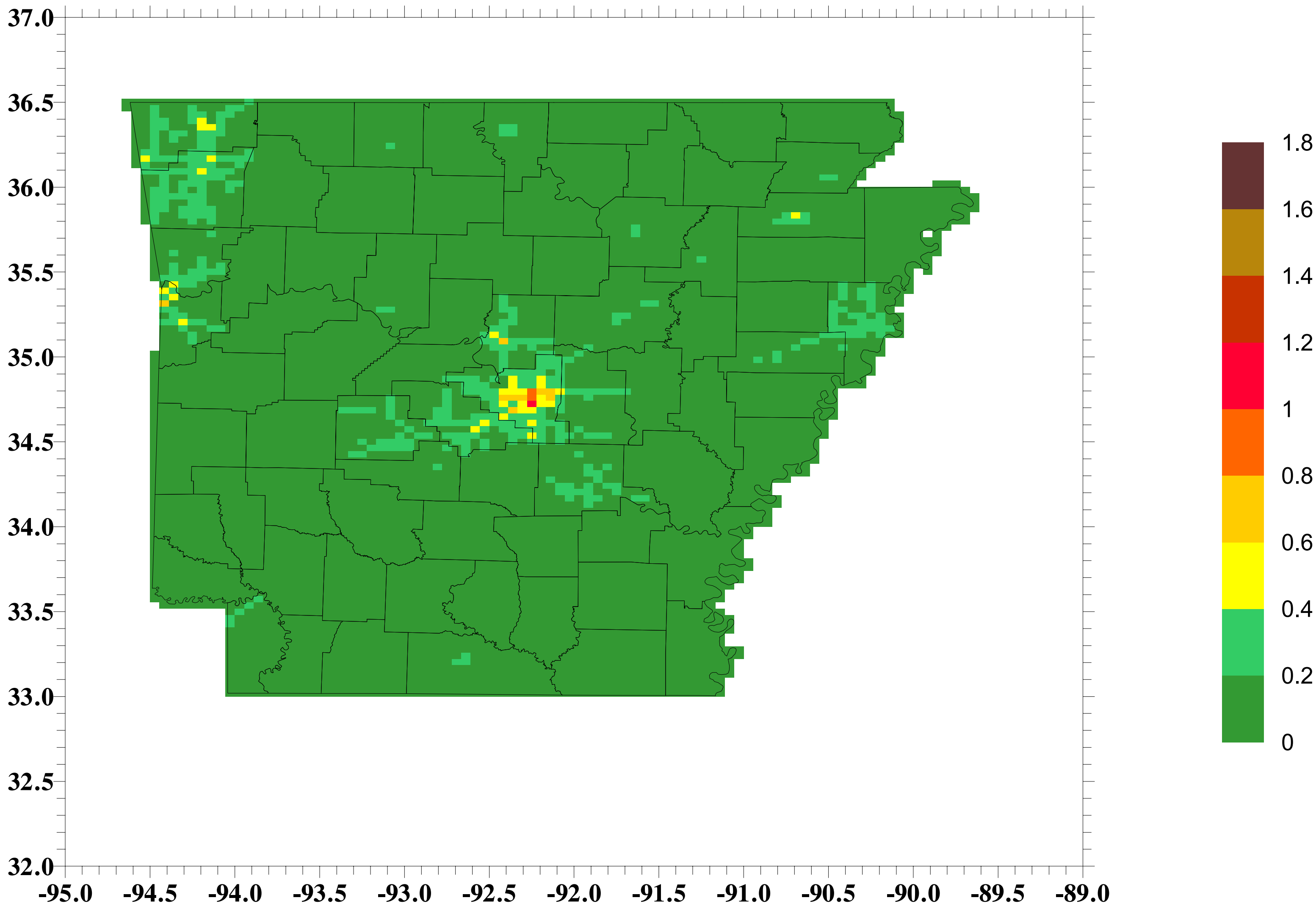


Figure 5-29.
Arkansas Area Sources Summer Weekday PM2.5 Emissions (tpd)

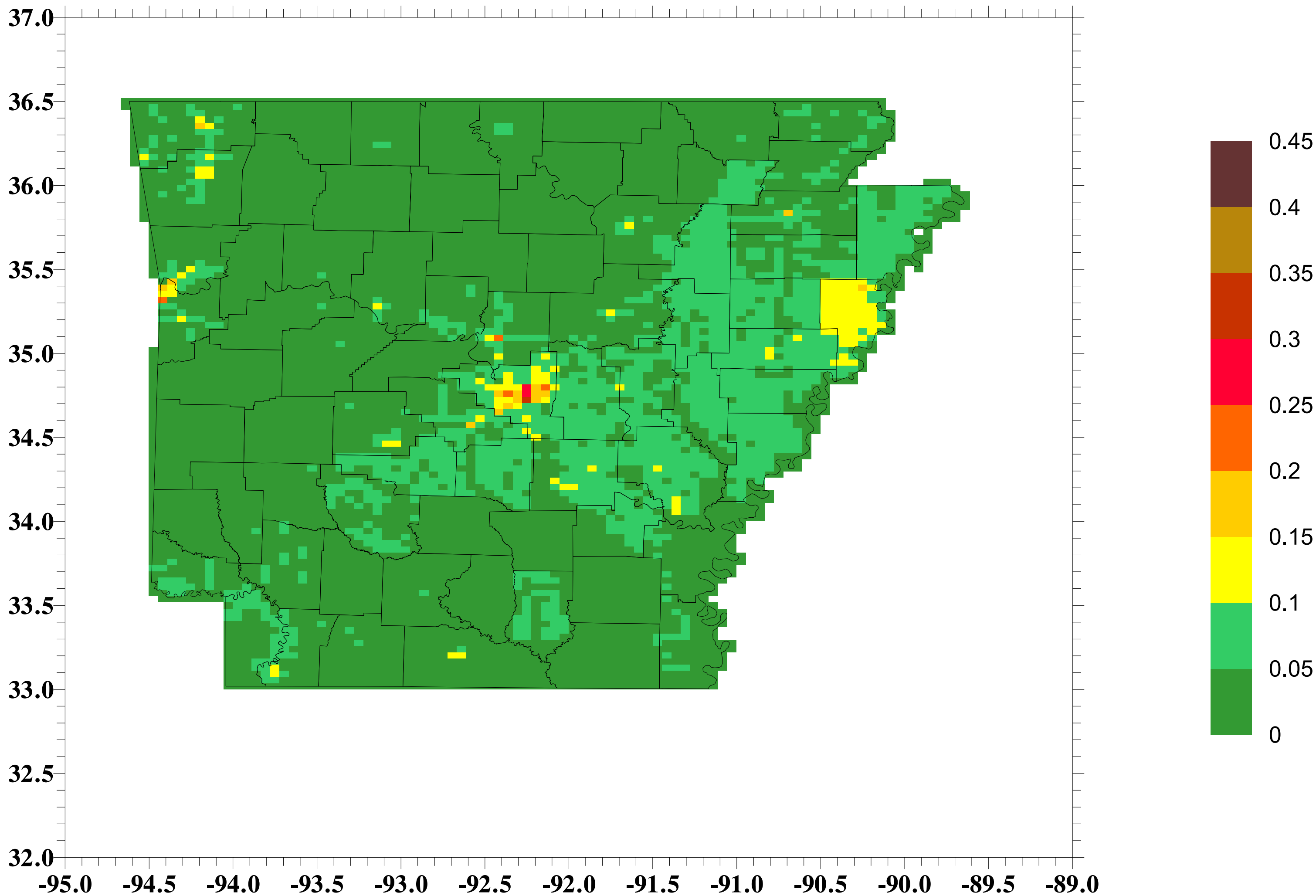


Figure 5-30.

Arkansas Area Sources Summer Weekday SOx Emissions (tpd)

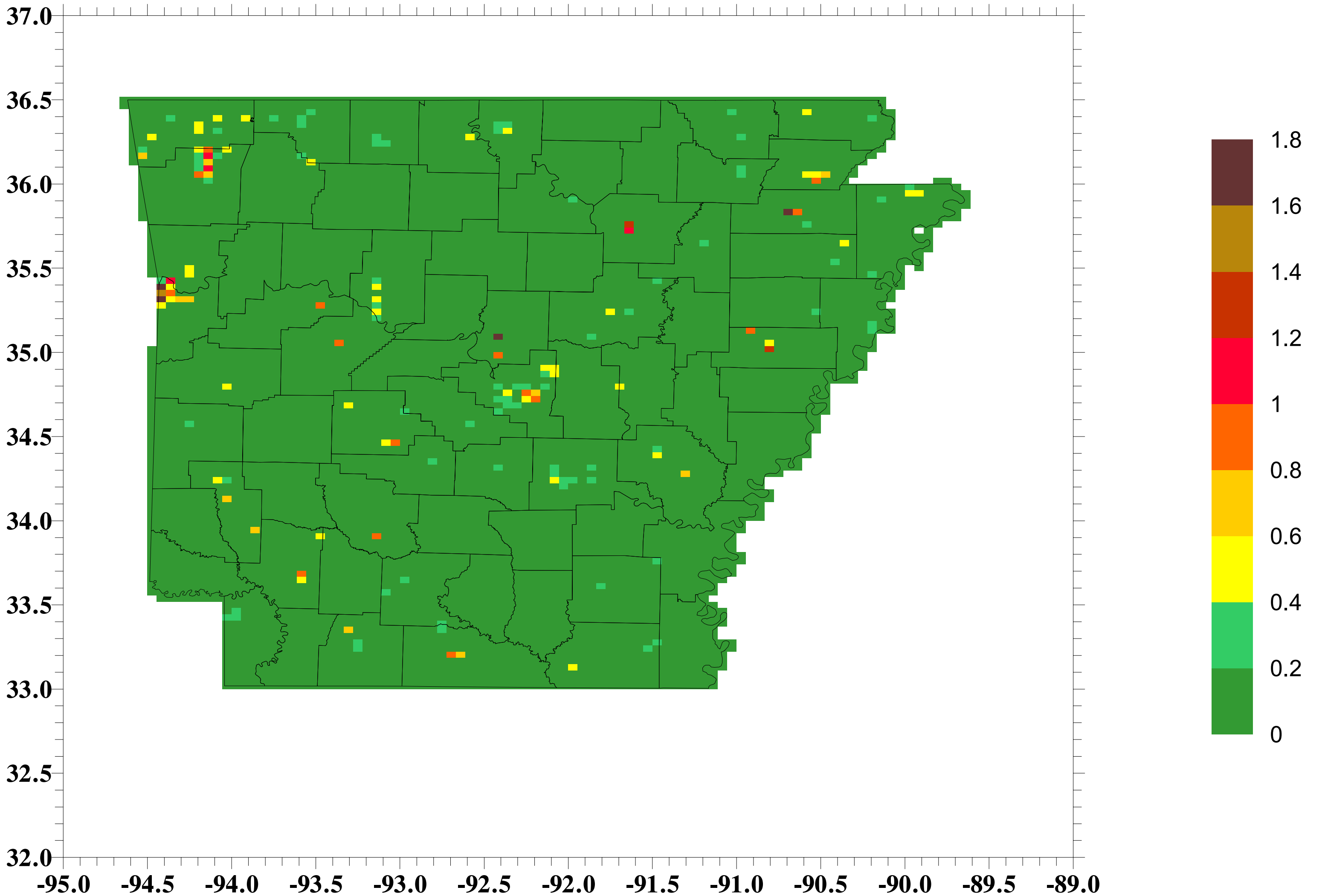


Figure 5-31.
Arkansas Area Sources Summer Weekday NH3 Emissions (tpd)

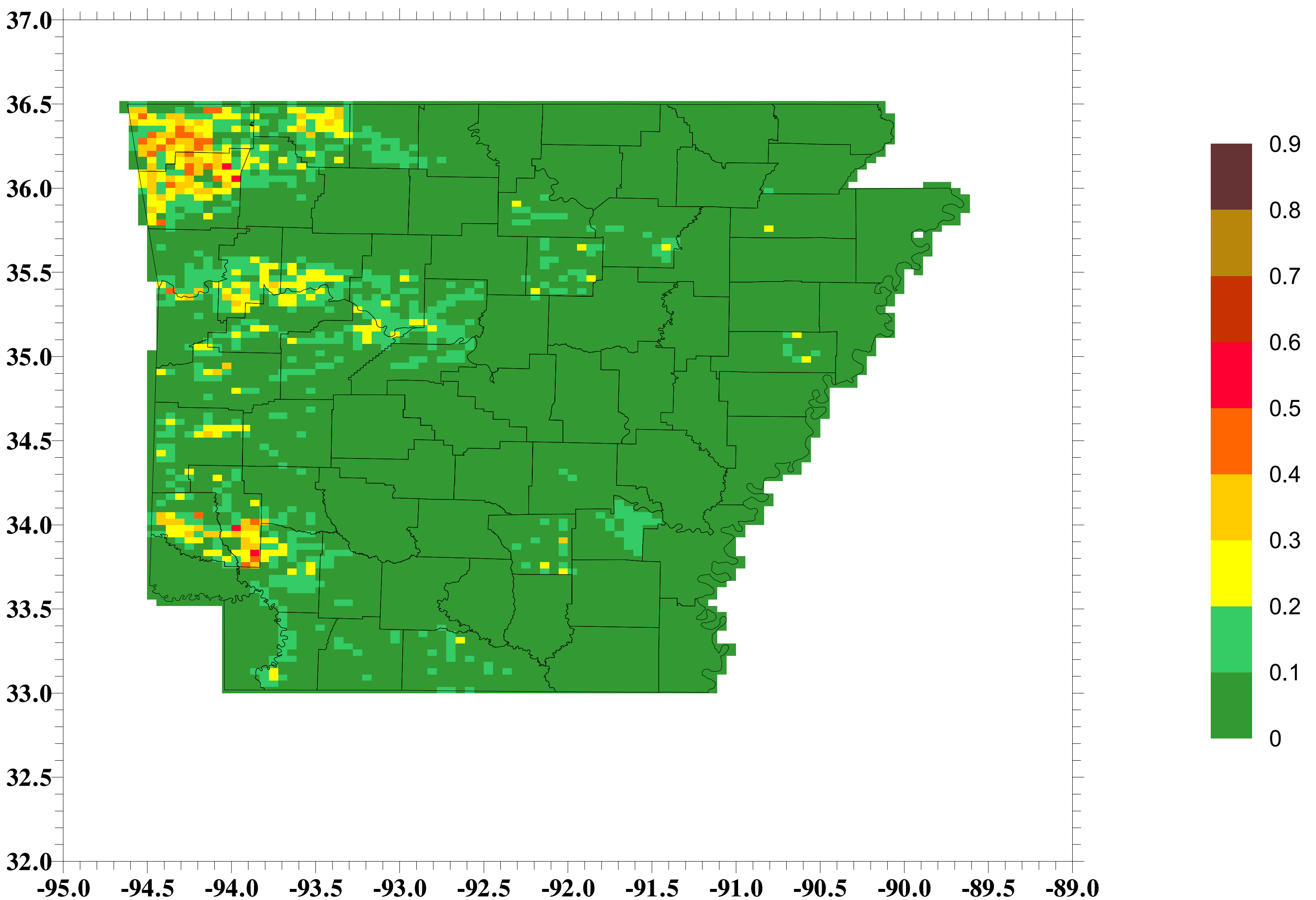


Figure 32.

Arkansas Off-road Sources Summer Weekday VOC Emissions (tpd)

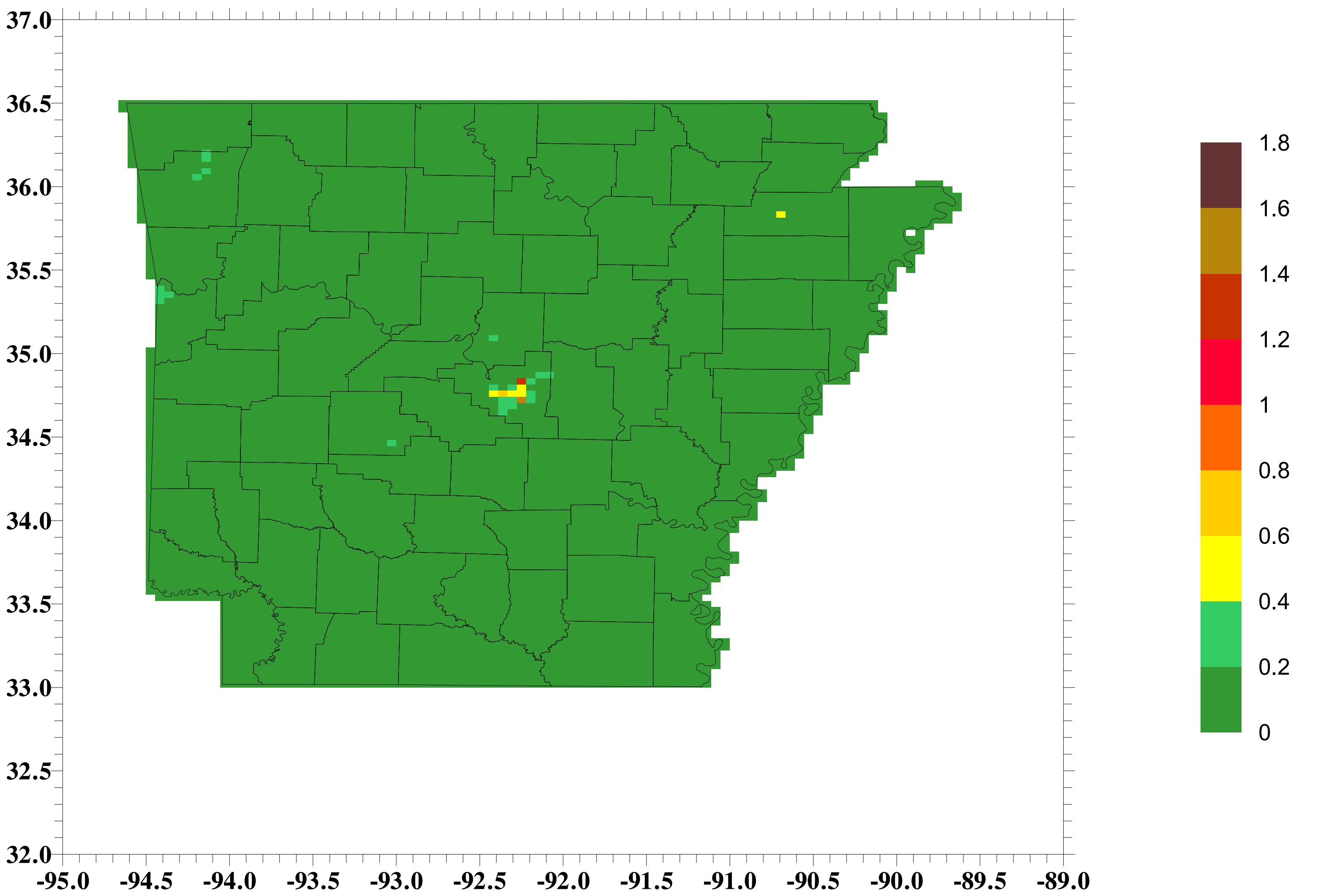


Figure 5-33.

Arkansas Off-road Sources Summer Weekday NOx Emissions (tpd)

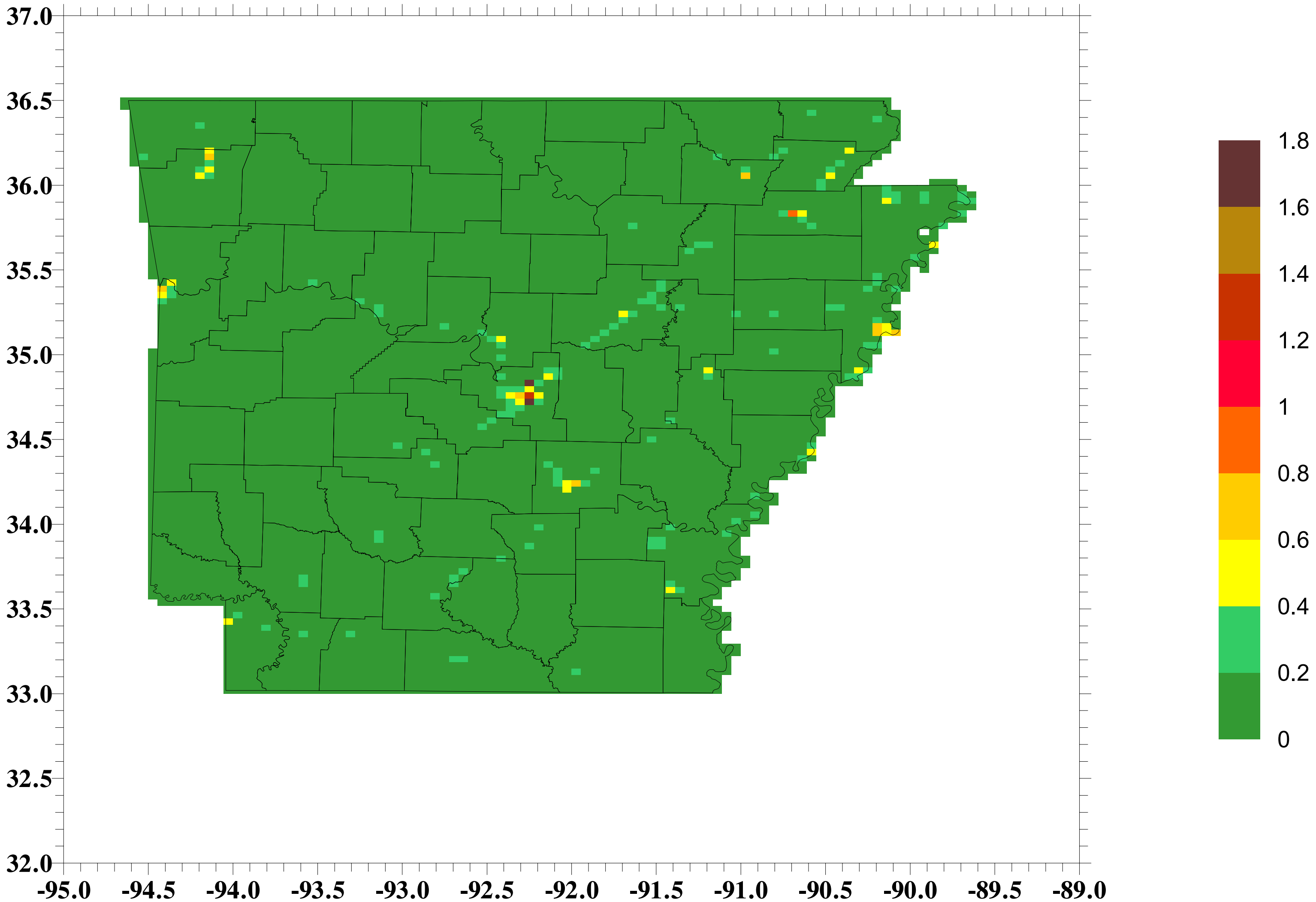


Figure 5-34.

Arkansas Off-road Sources Summer Weekday CO Emissions (tpd)

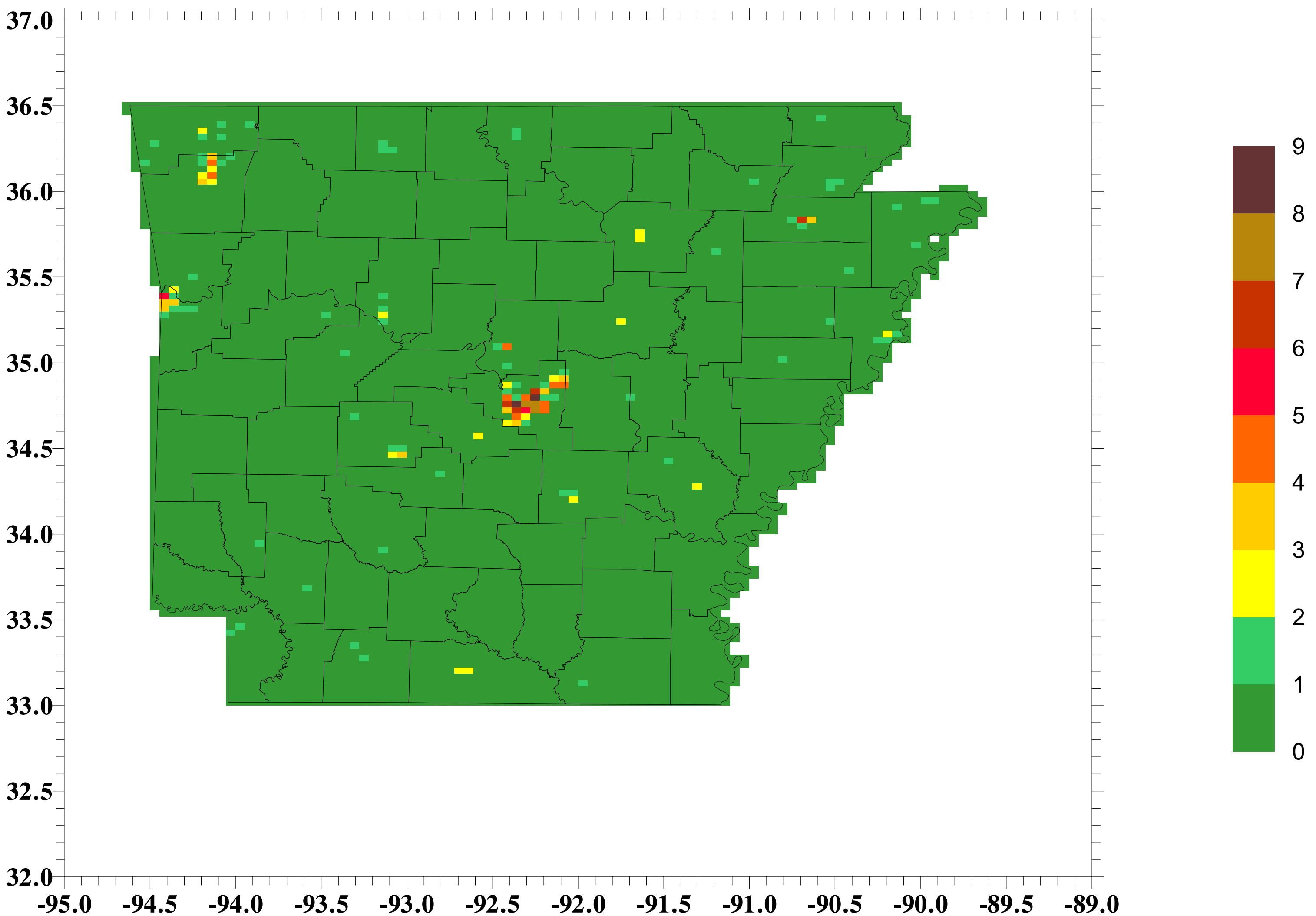


Figure 5-35.
Arkansas Off-road Sources Summer Weekday PM10 Emissions (tpd)

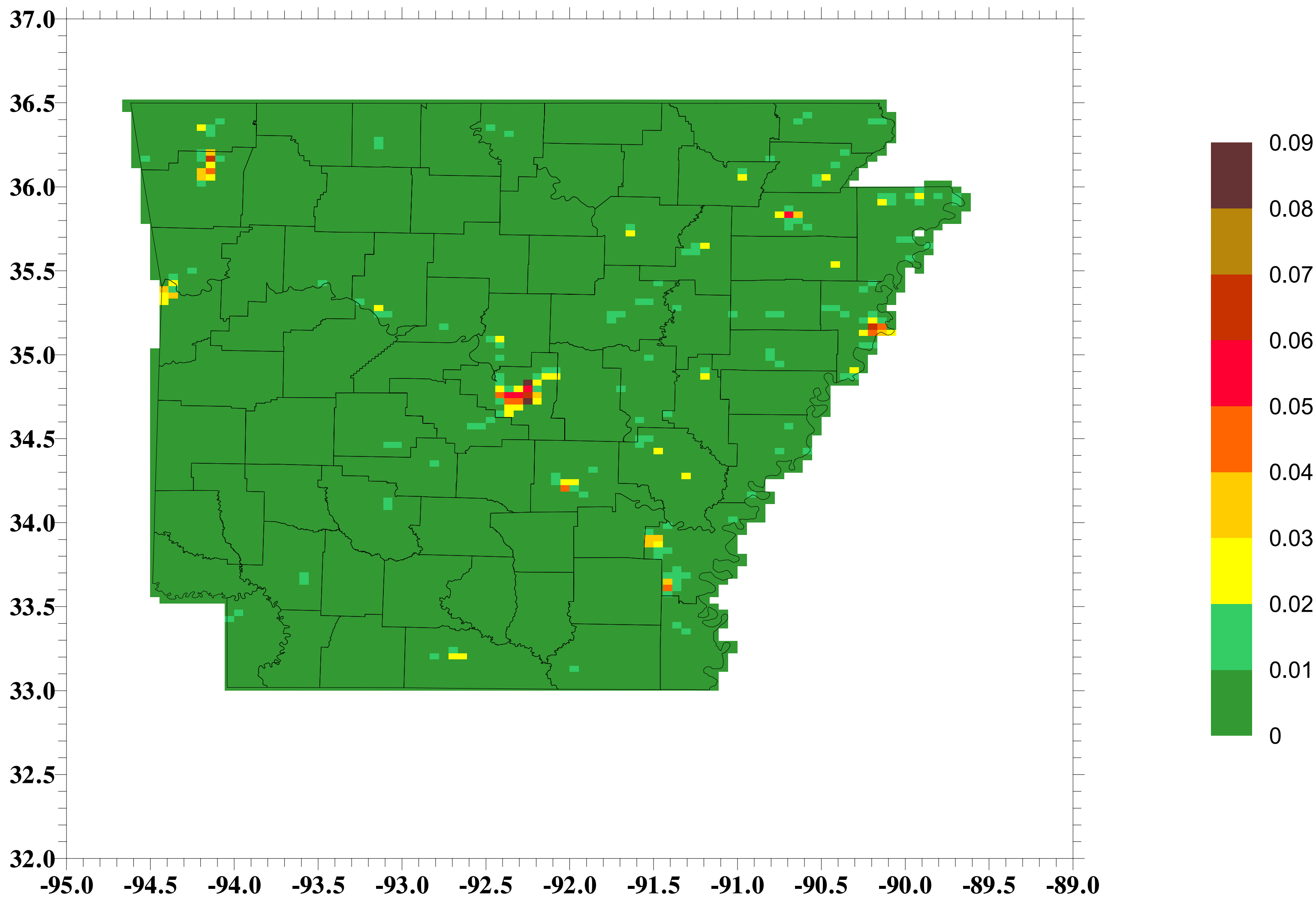


Figure 5-36.
Arkansas Off-road Sources Summer Weekday PM2.5 Emissions (tpd)

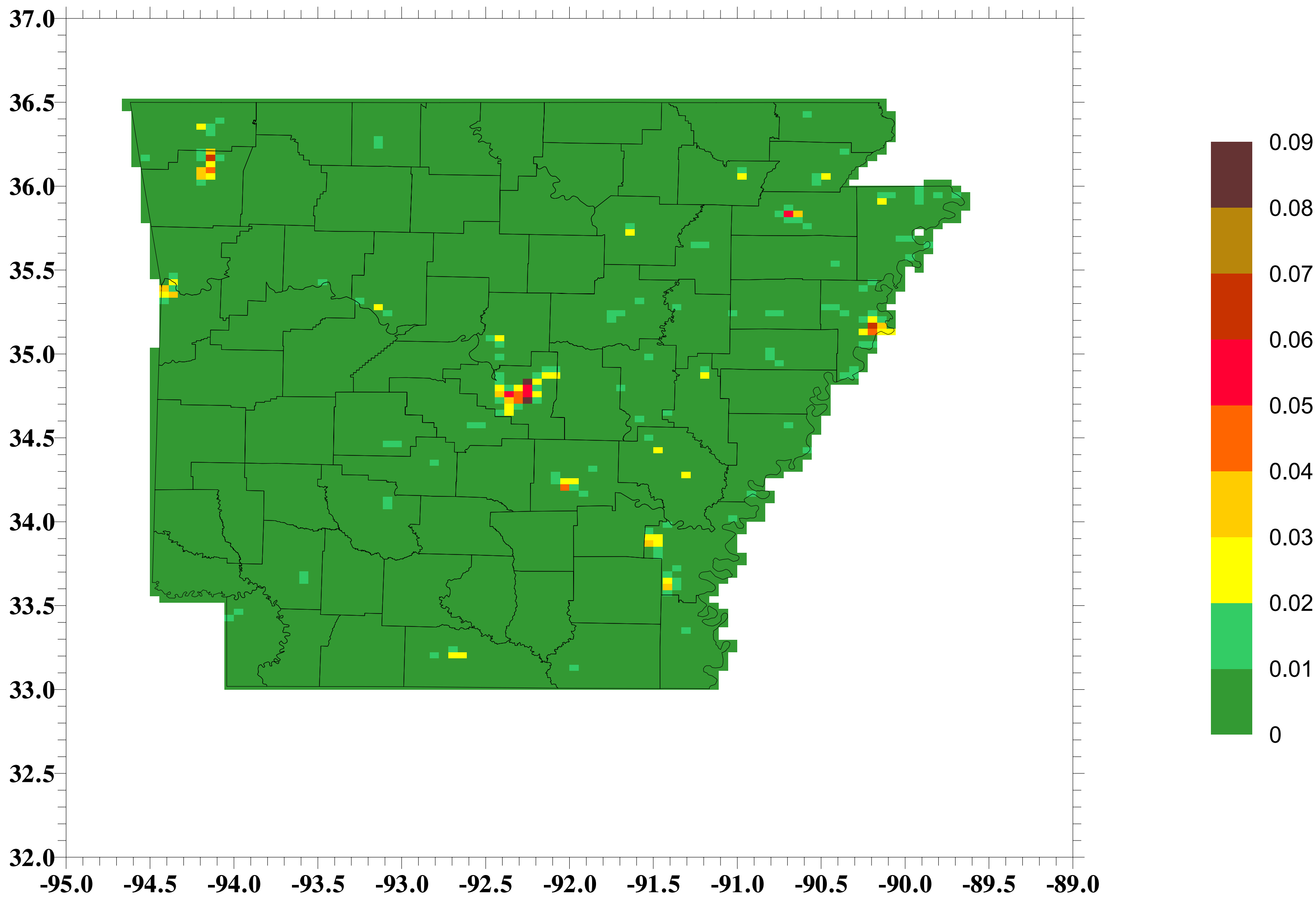


Figure 5-37.

Arkansas Off-road Sources Summer Weekday SOx Emissions (tpd)

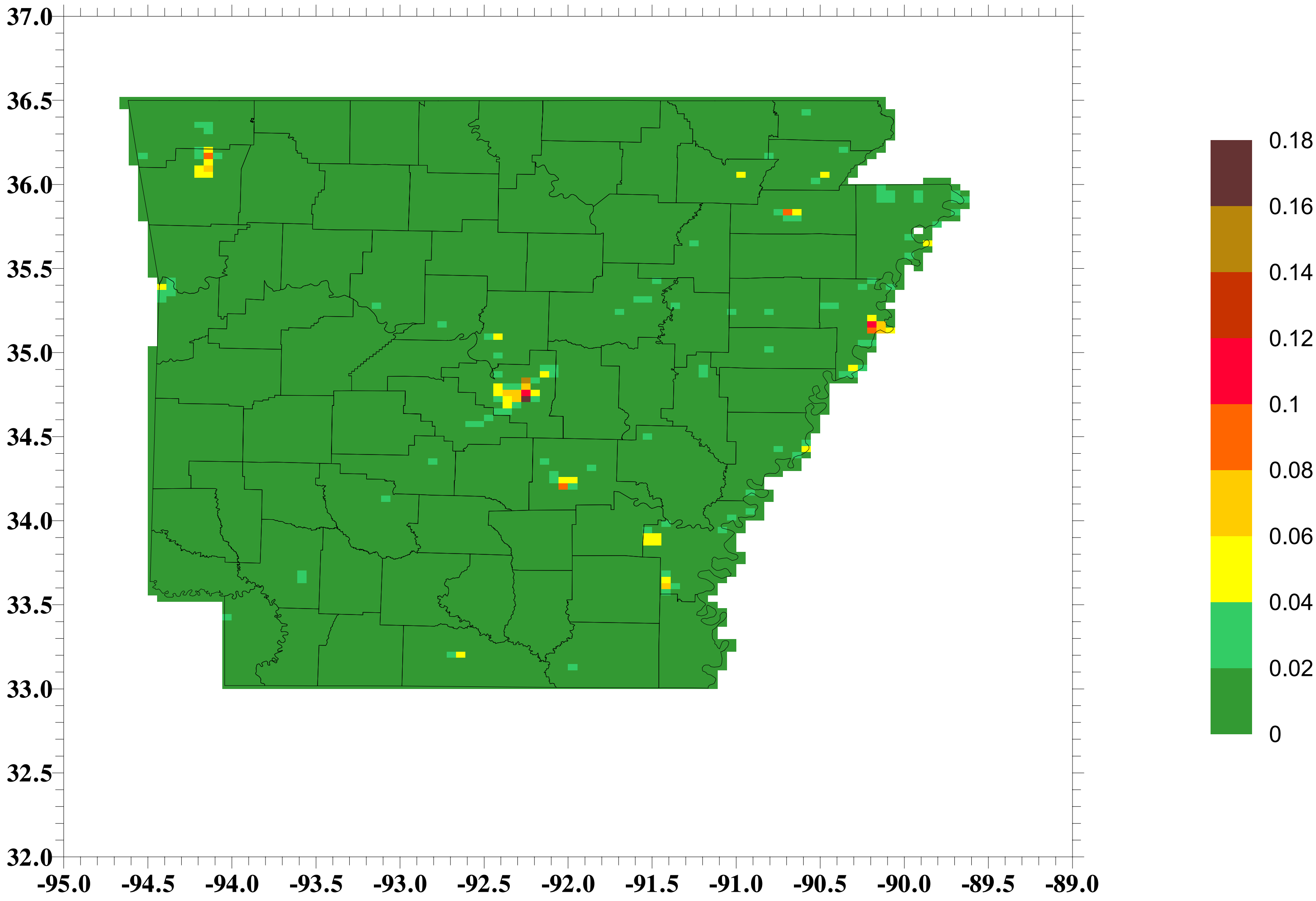


Figure 5-38

Arkansas Off-road Sources Summer Weekday NH3 Emissions (tpd)

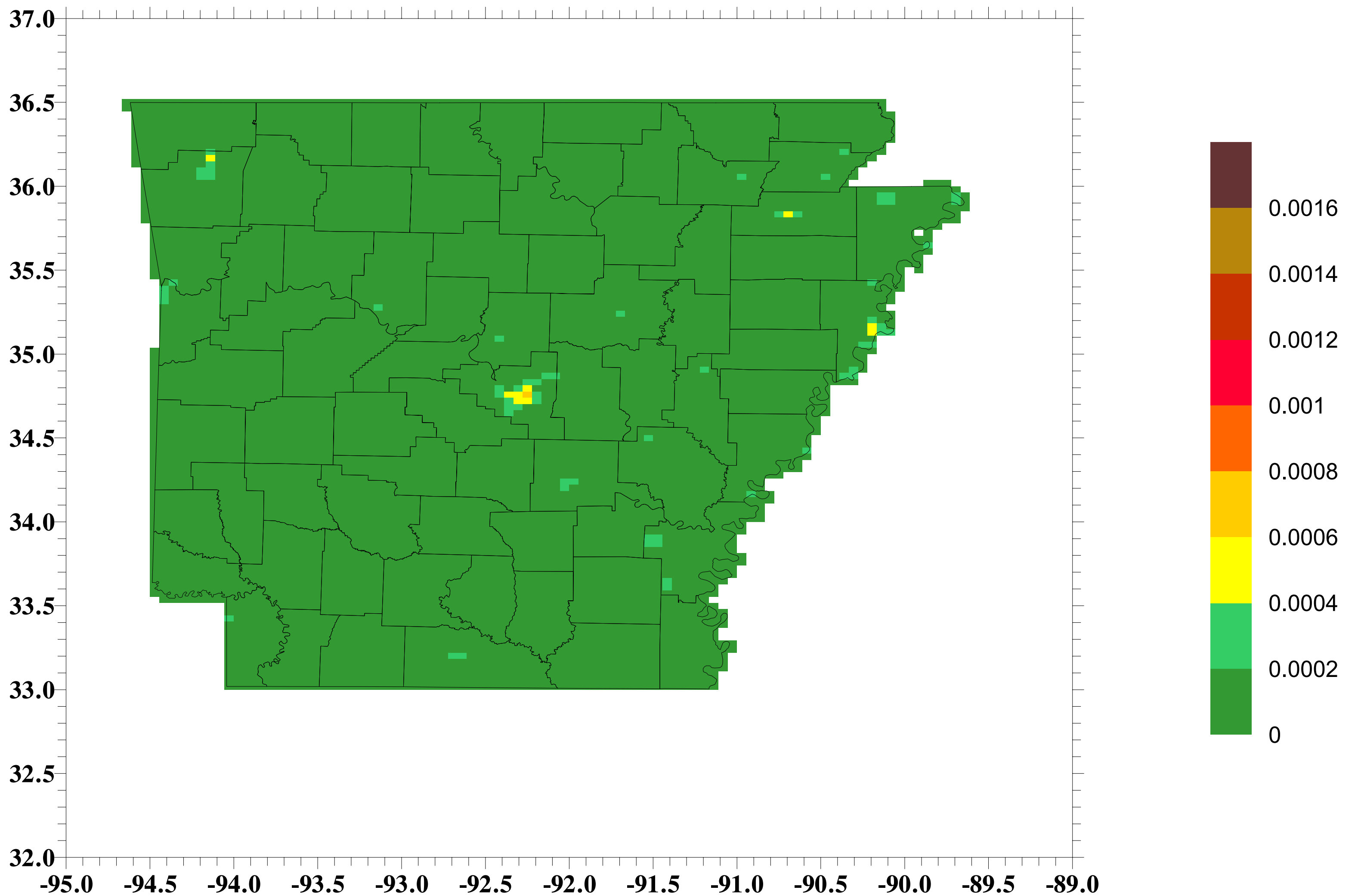


Figure 5-39.
Arkansas On-road Sources Summer Weekday VOC Emissions (tpd)

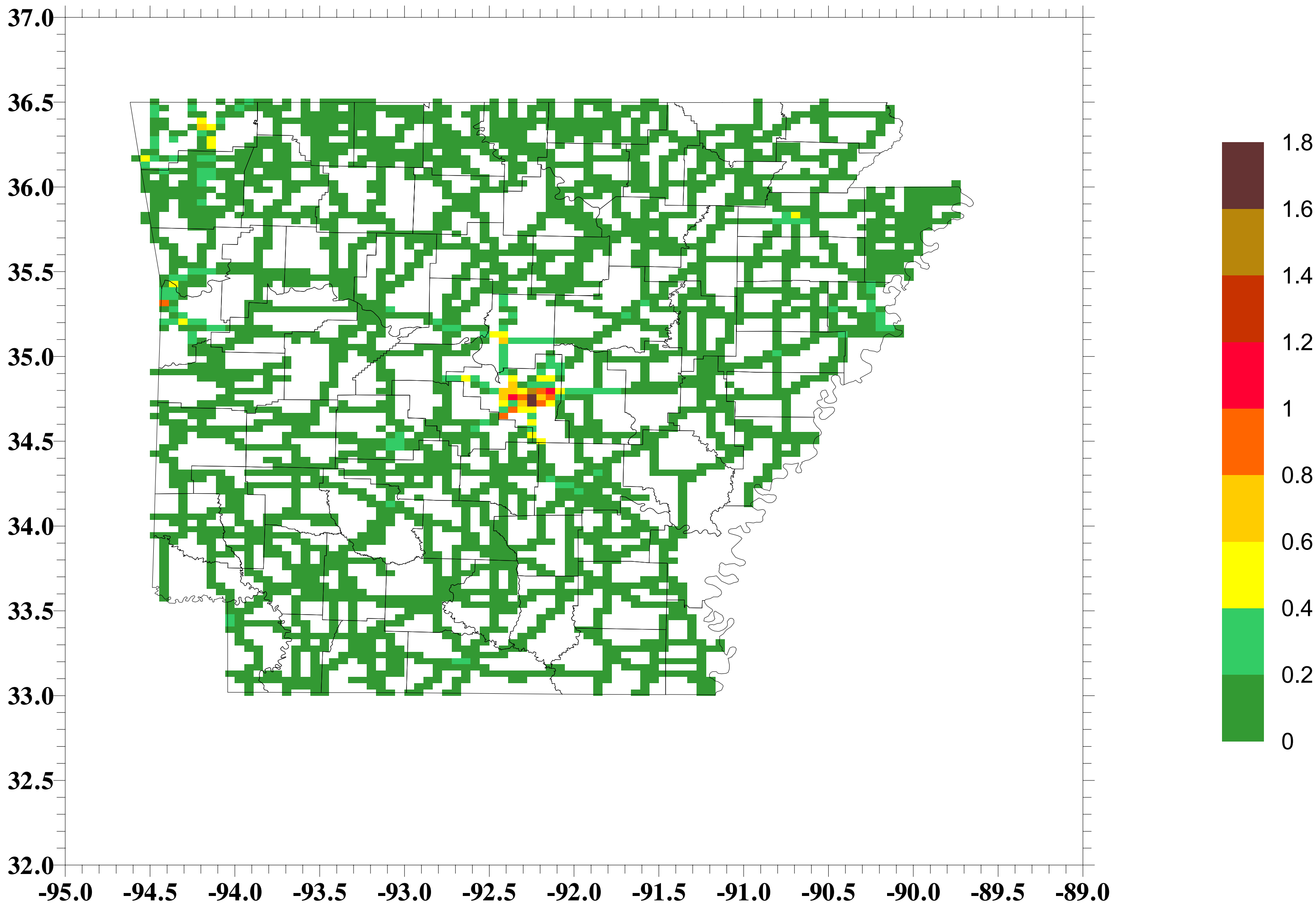


Figure 5-40.

Arkansas On-road Sources Summer Weekday NOx Emissions (tpd)

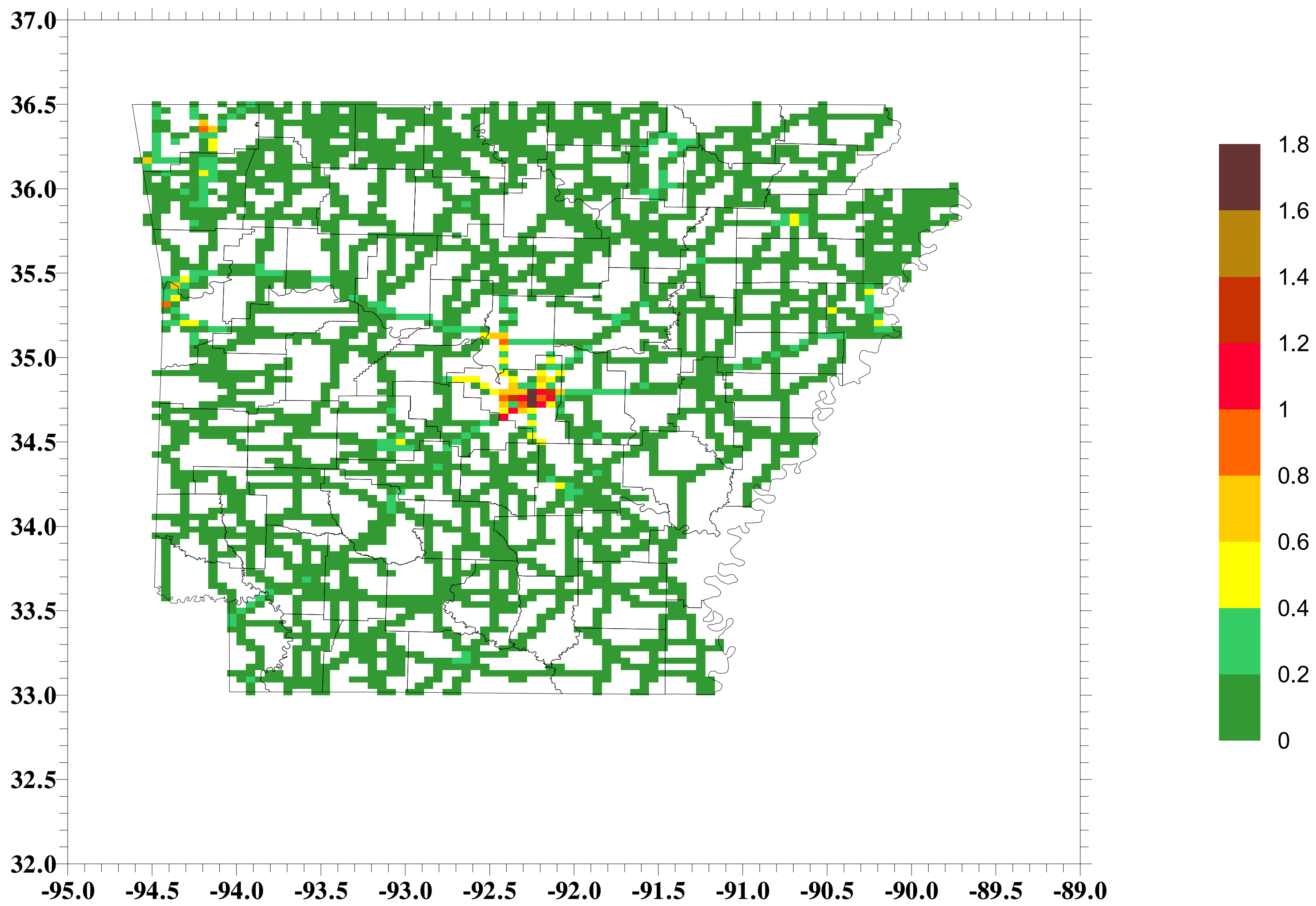


Figure 5-41.

Arkansas On-road Sources Summer Weekday CO Emissions (tpd)

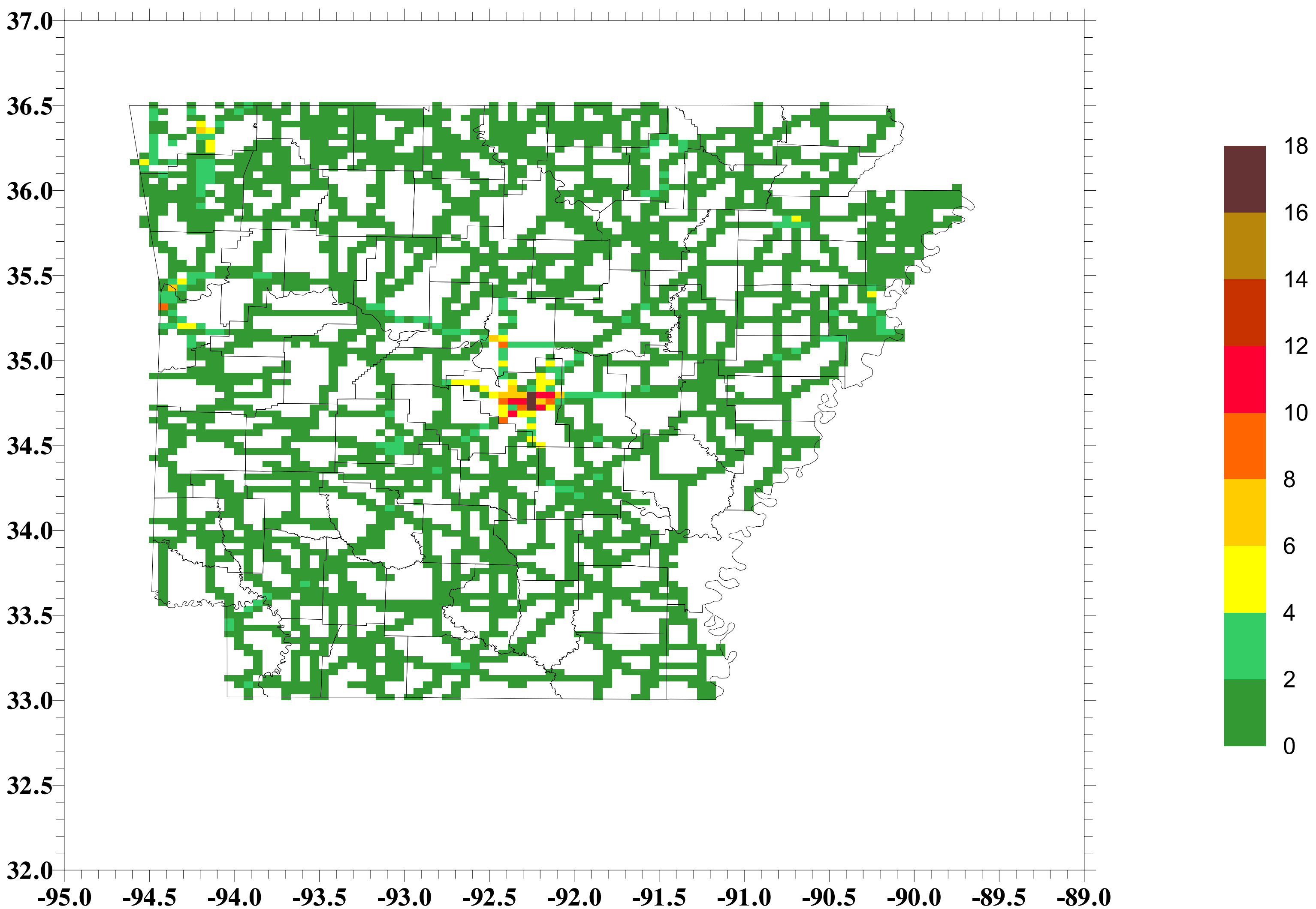


Figure 5-42.

Arkansas On-road Sources Summer Weekday PM10 Emissions (tpd)

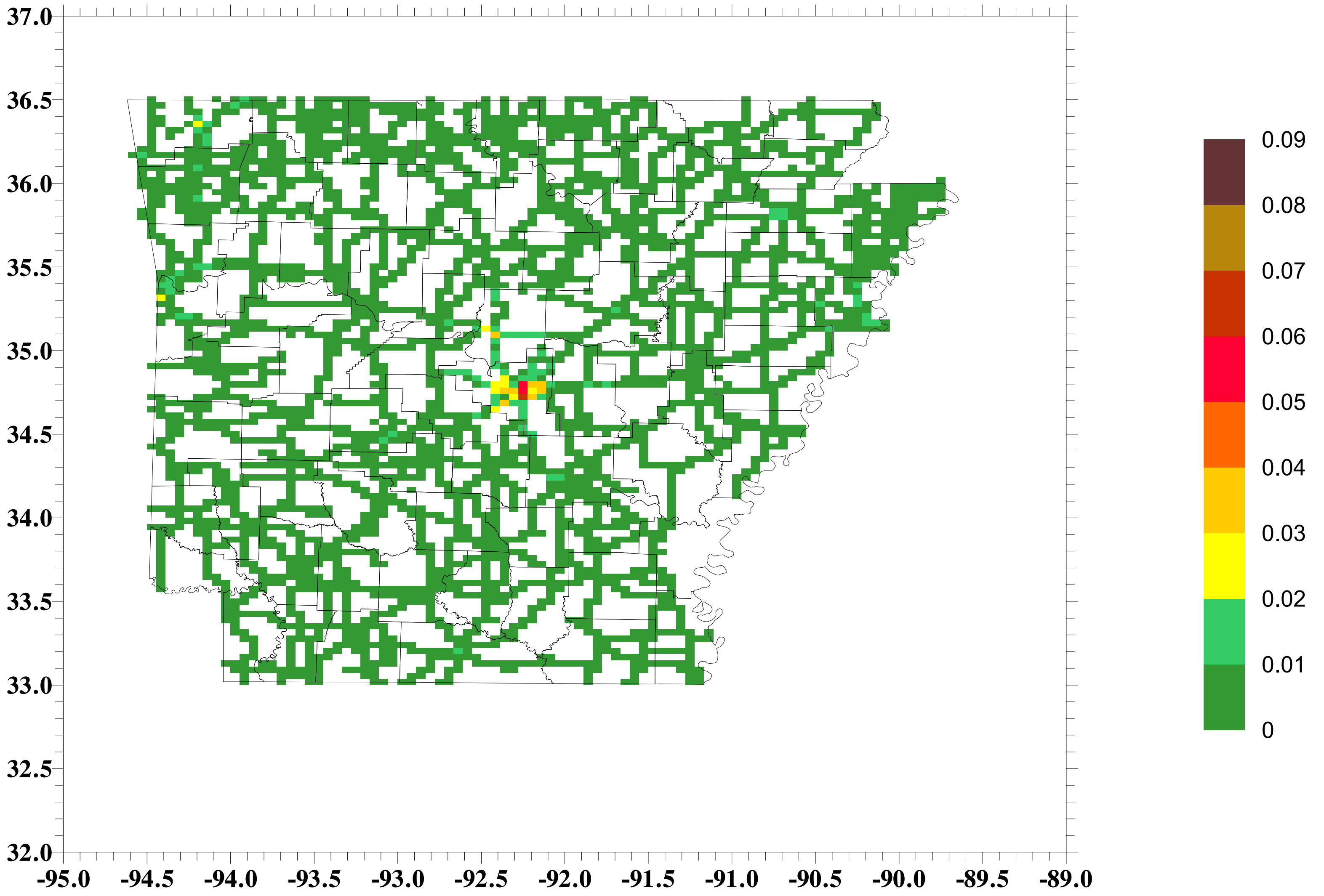


Figure 5-43.

Arkansas On-road Sources Summer Weekday PM2.5 Emissions (tpd)

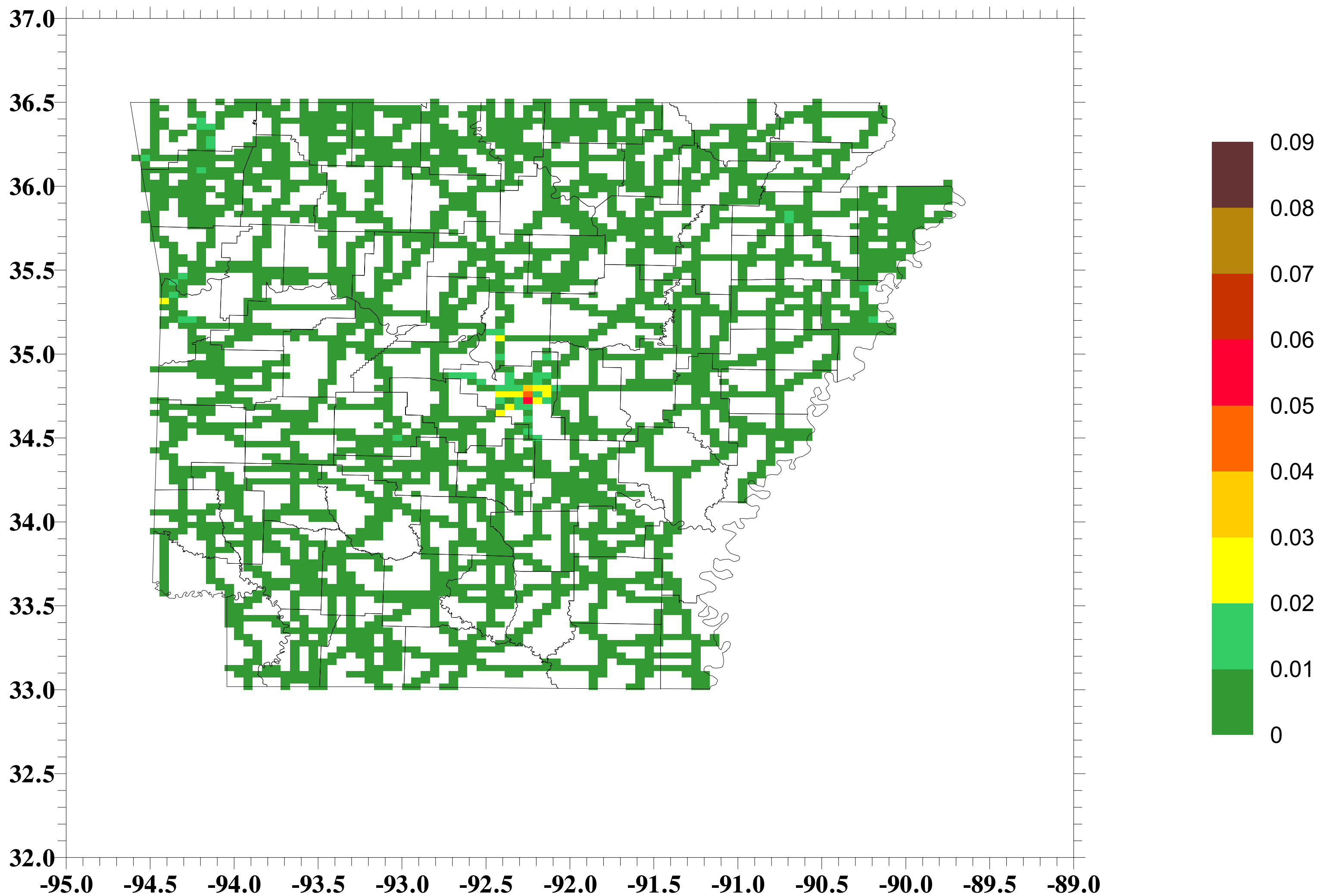


Figure 5-44.
Arkansas On-road Sources Summer Weekday SOx Emissions (tpd)

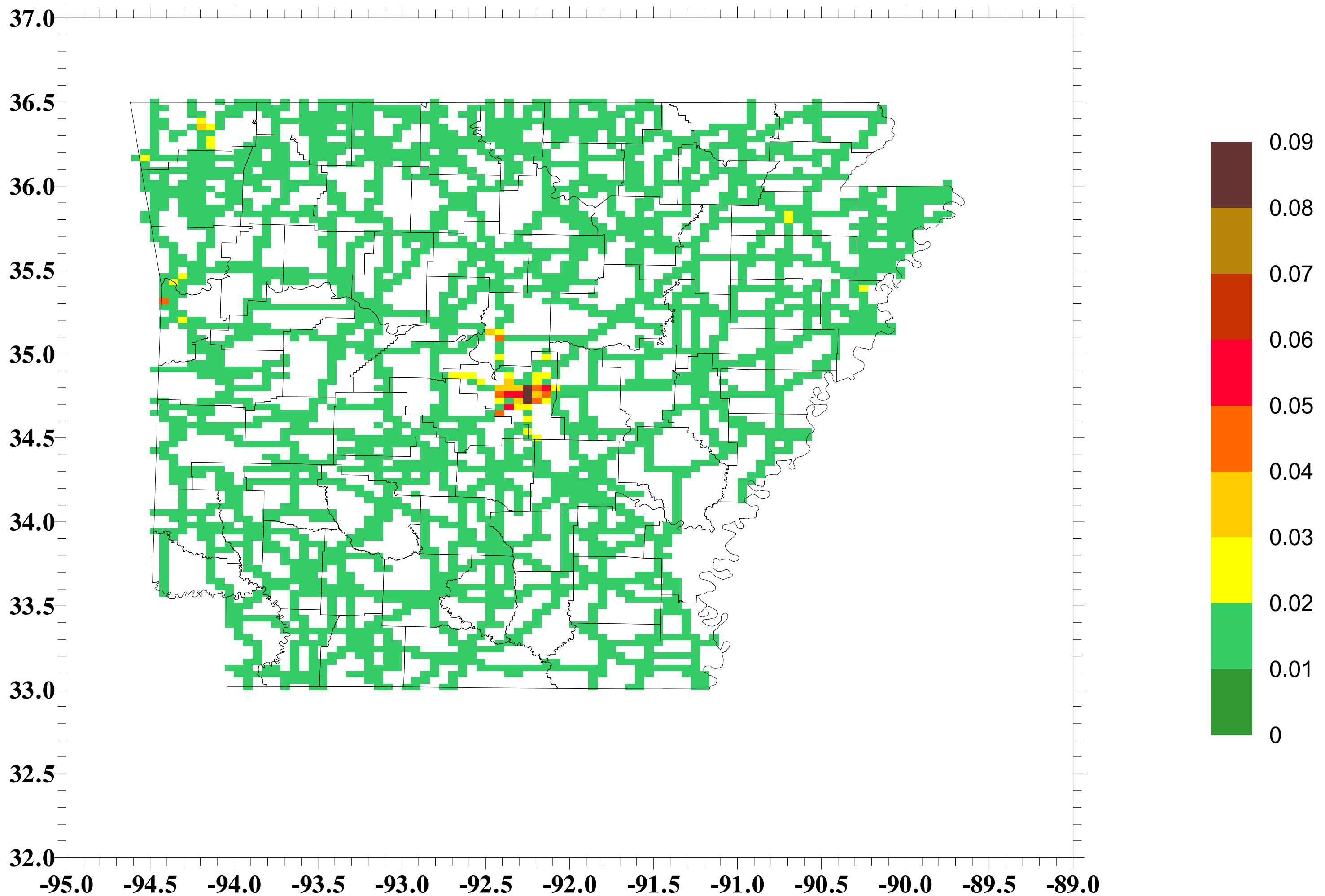


Figure 5-45.

Arkansas On-road Sources Summer Weekday NH3 Emissions (tpd)

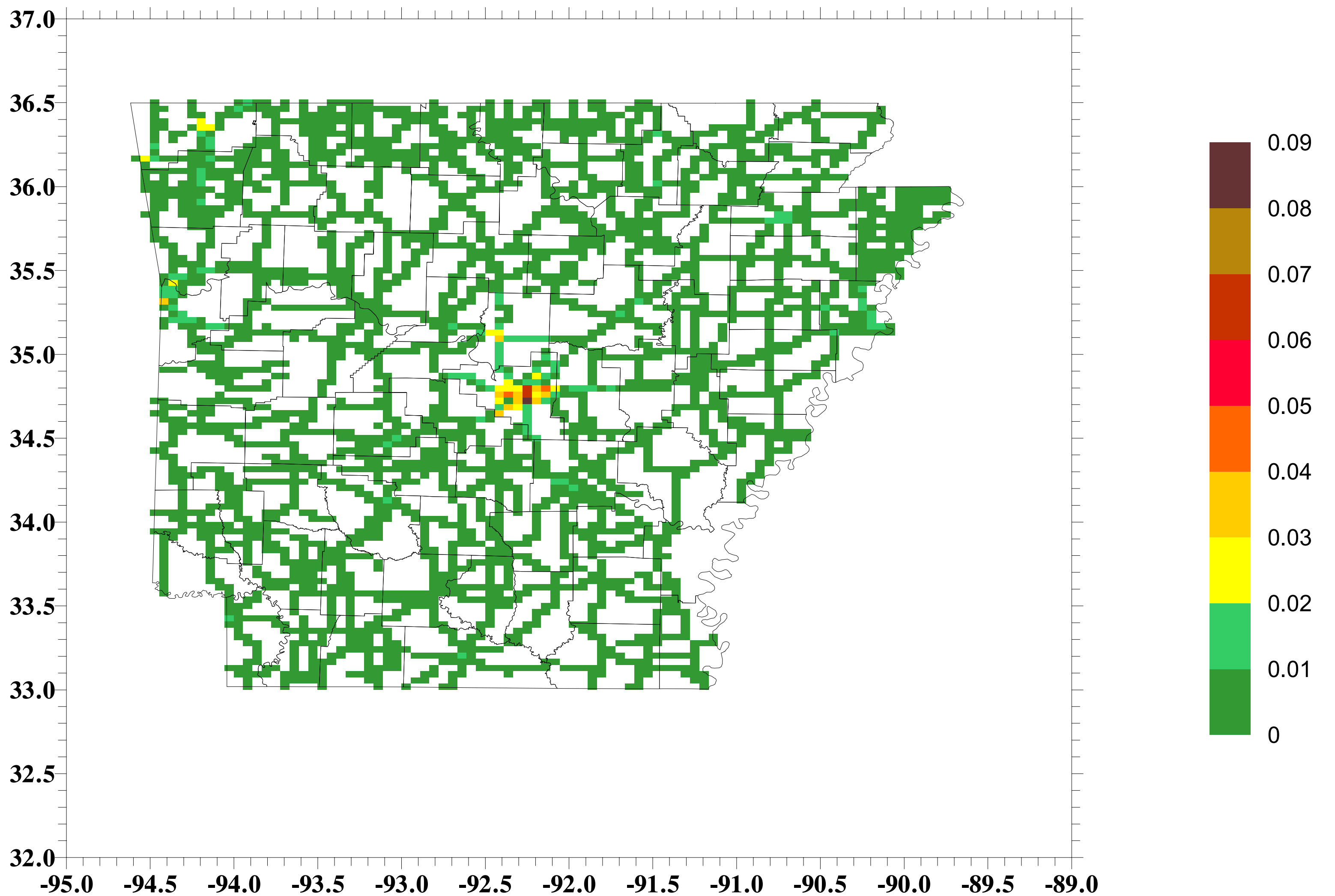


Figure 5-46.

Arkansas Area Sources Winter Weekday VOC Emissions (tpd)

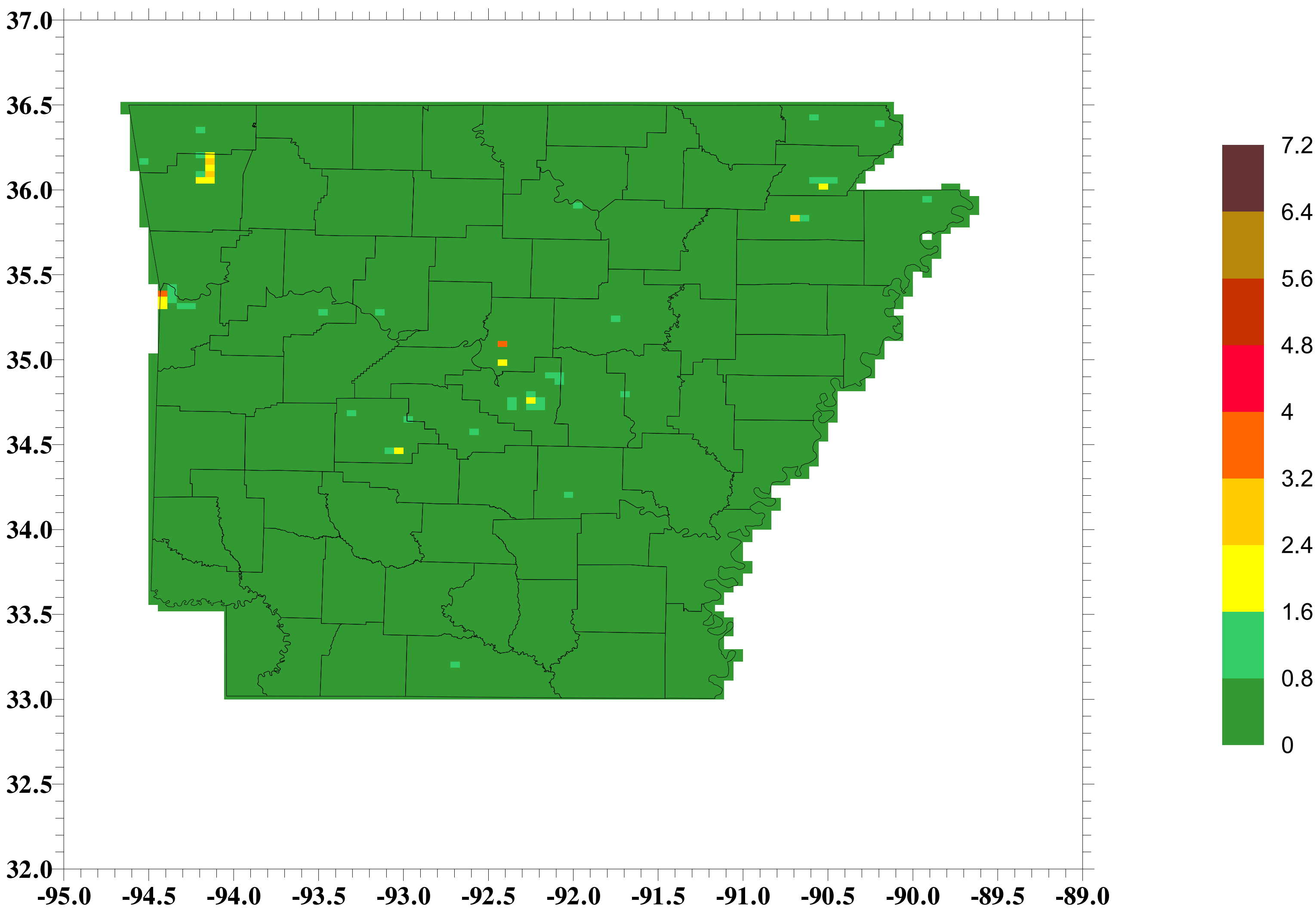


Figure 5-47.
Arkansas Area Sources Winter Weekday NOx Emissions (tpd)

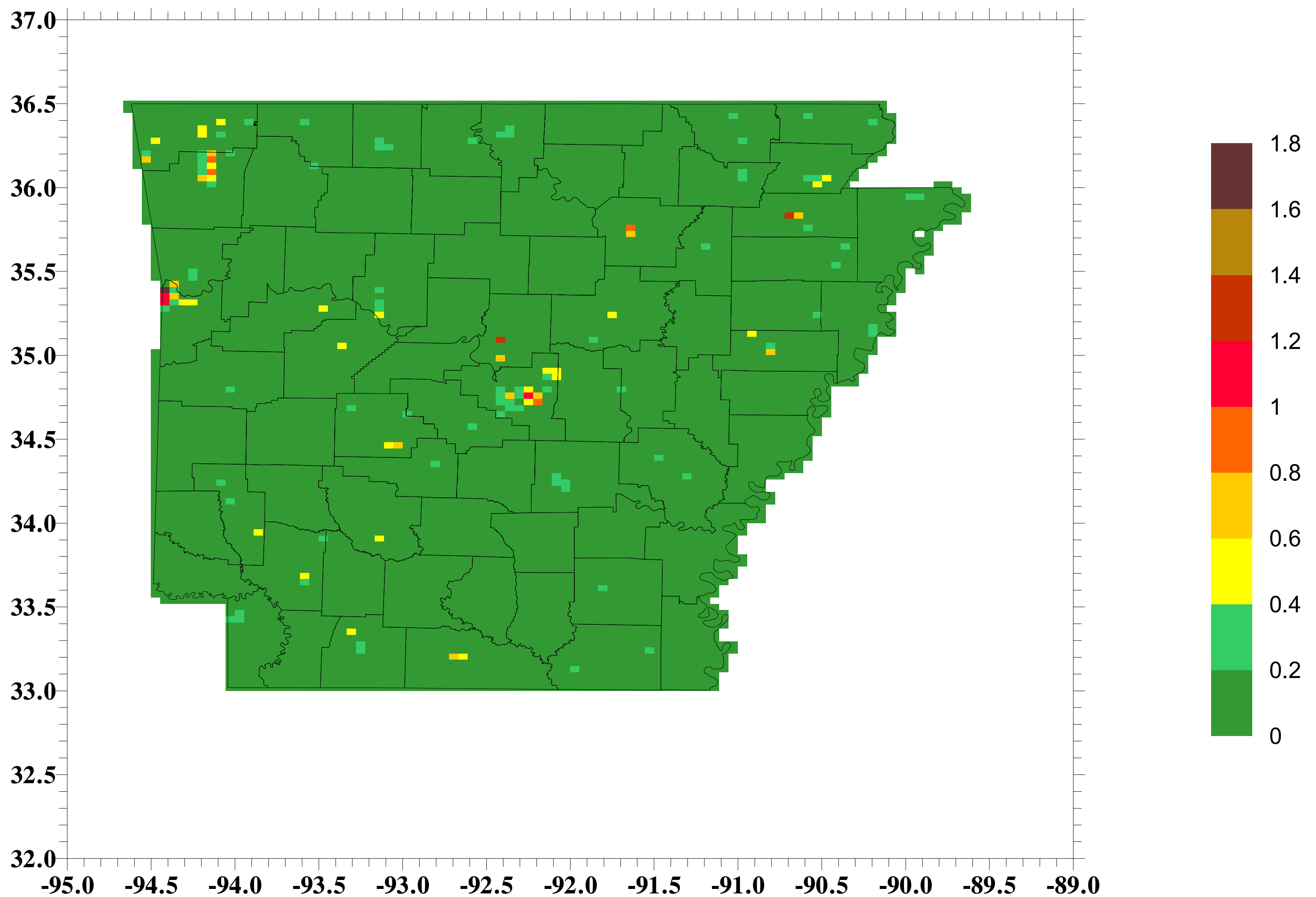


Figure 5-48.

Arkansas Area Sources Winter Weekday CO Emissions (tpd)

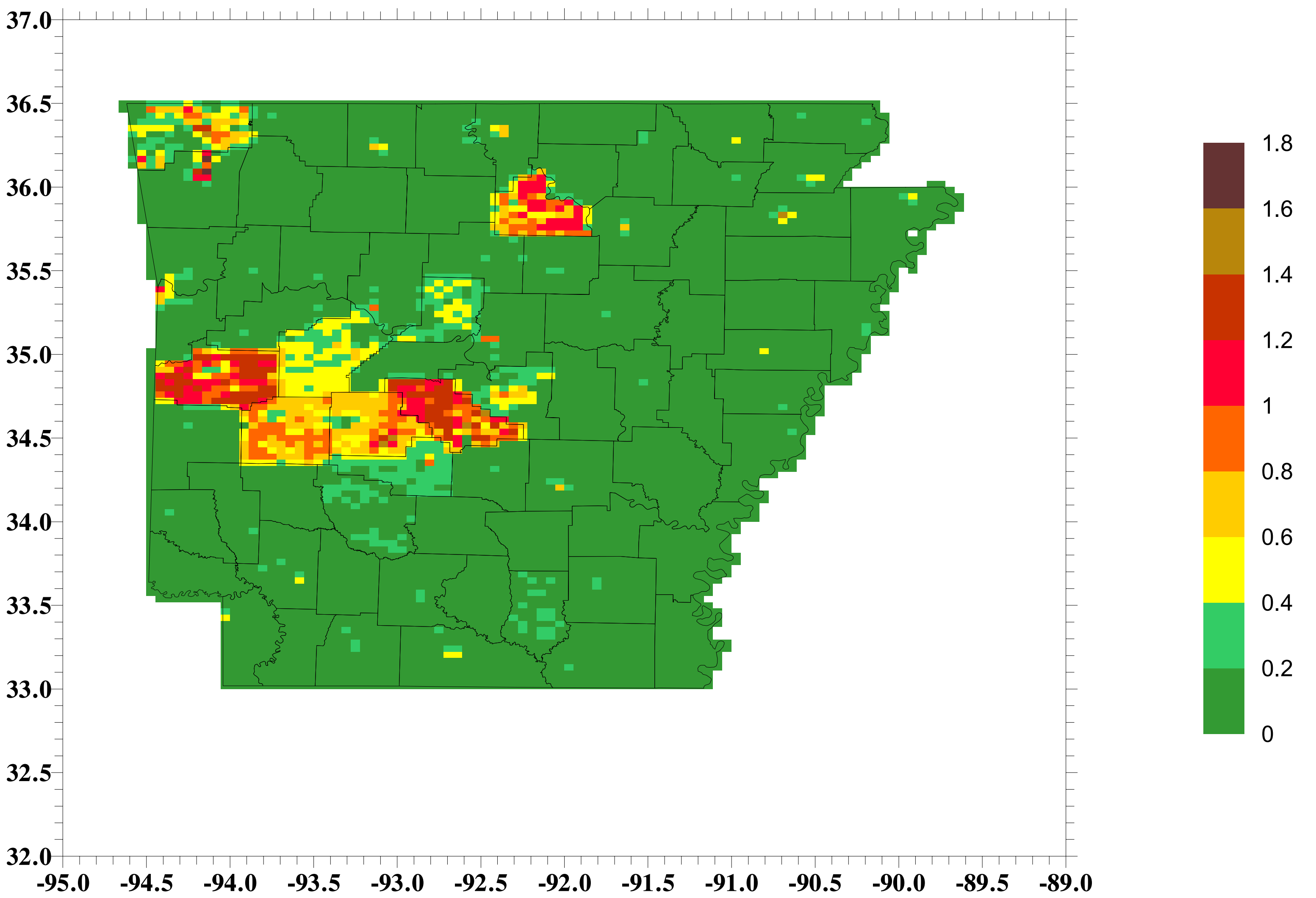


Figure 5-49.

Arkansas Area Sources Winter Weekday PM10 Emissions (tpd)

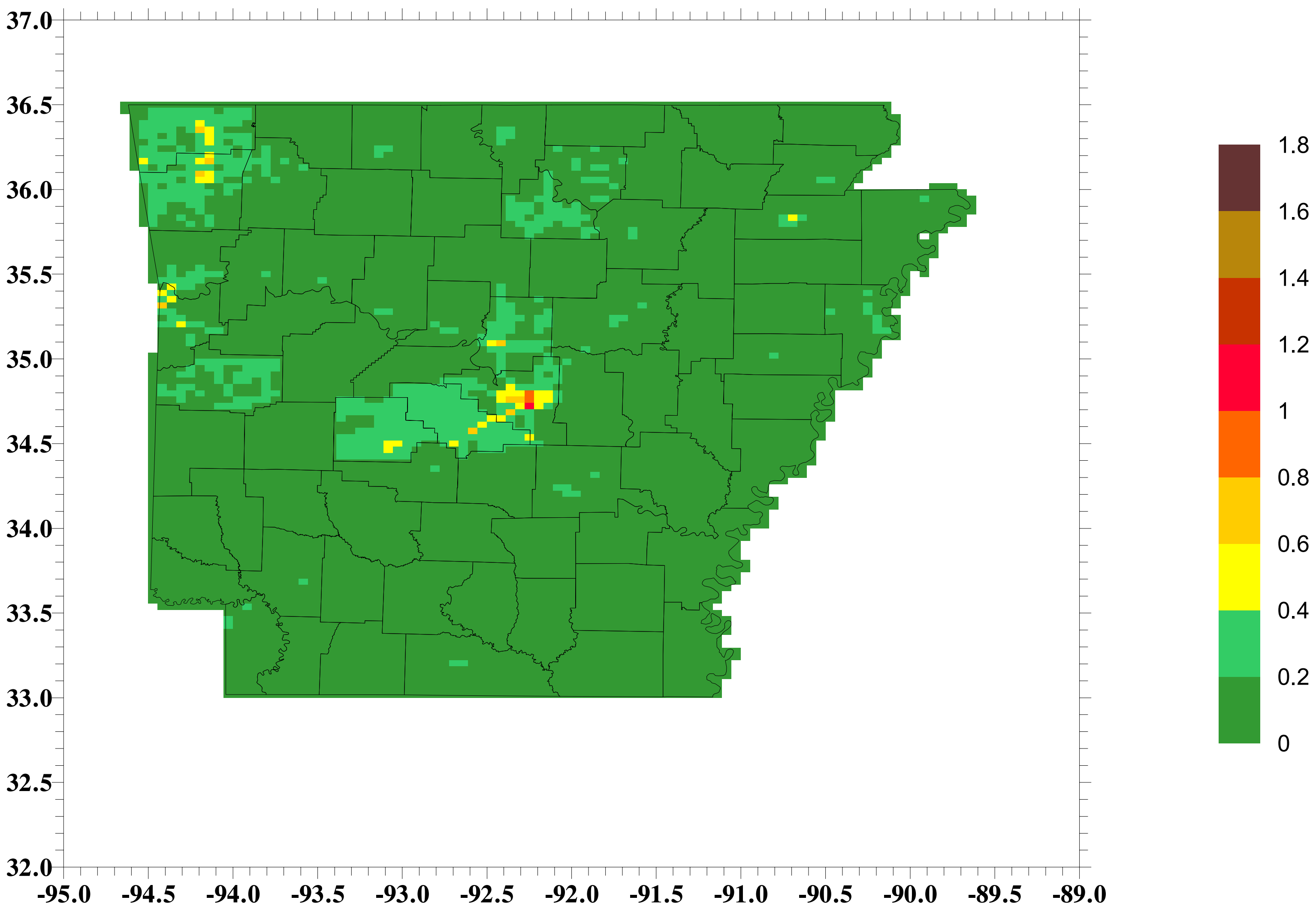


Figure 5-50.
Arkansas Area Sources Winter Weekday PM2.5 Emissions (tpd)

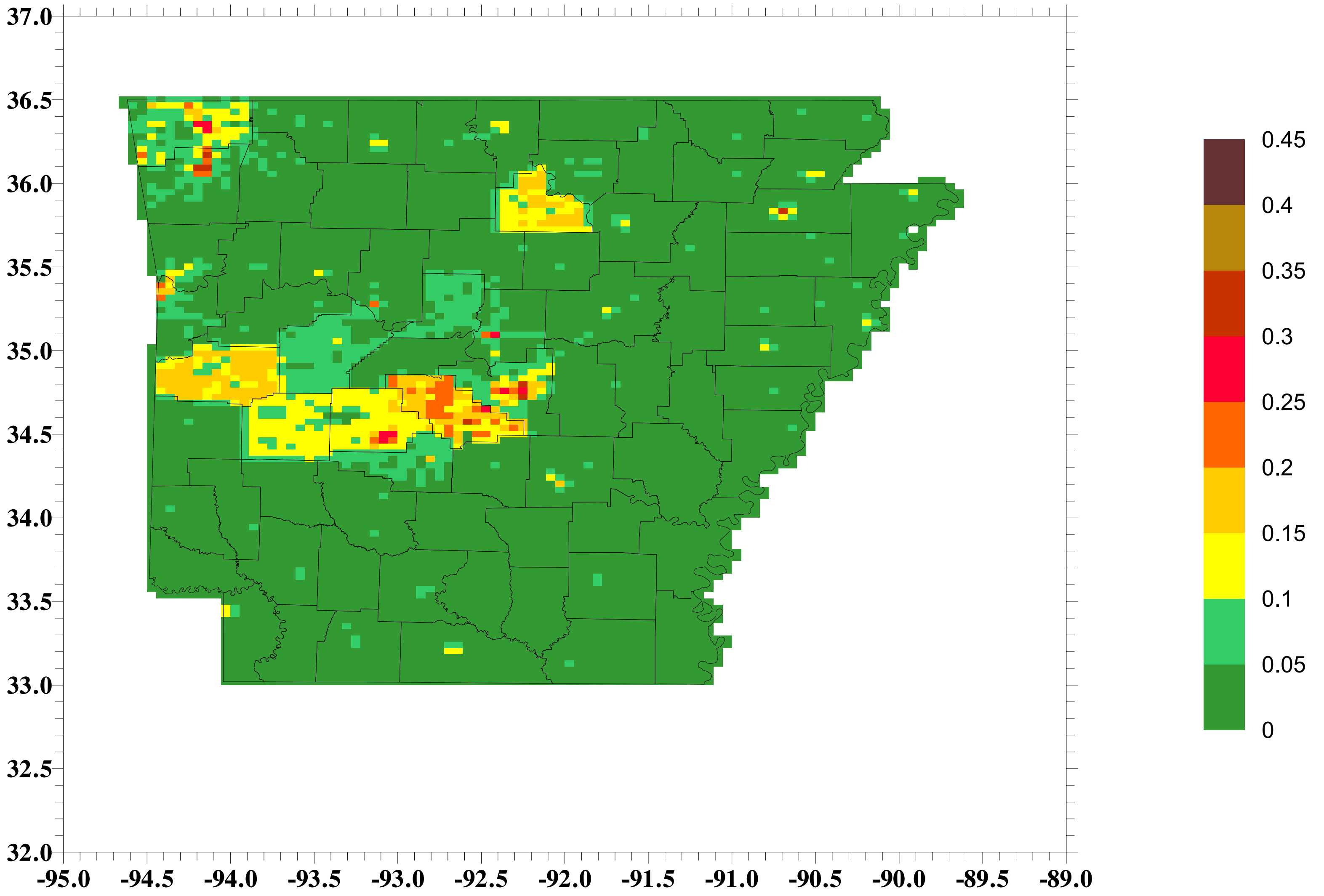


Figure 5-51.

Arkansas Area Sources Winter Weekday SOx Emissions (tpd)

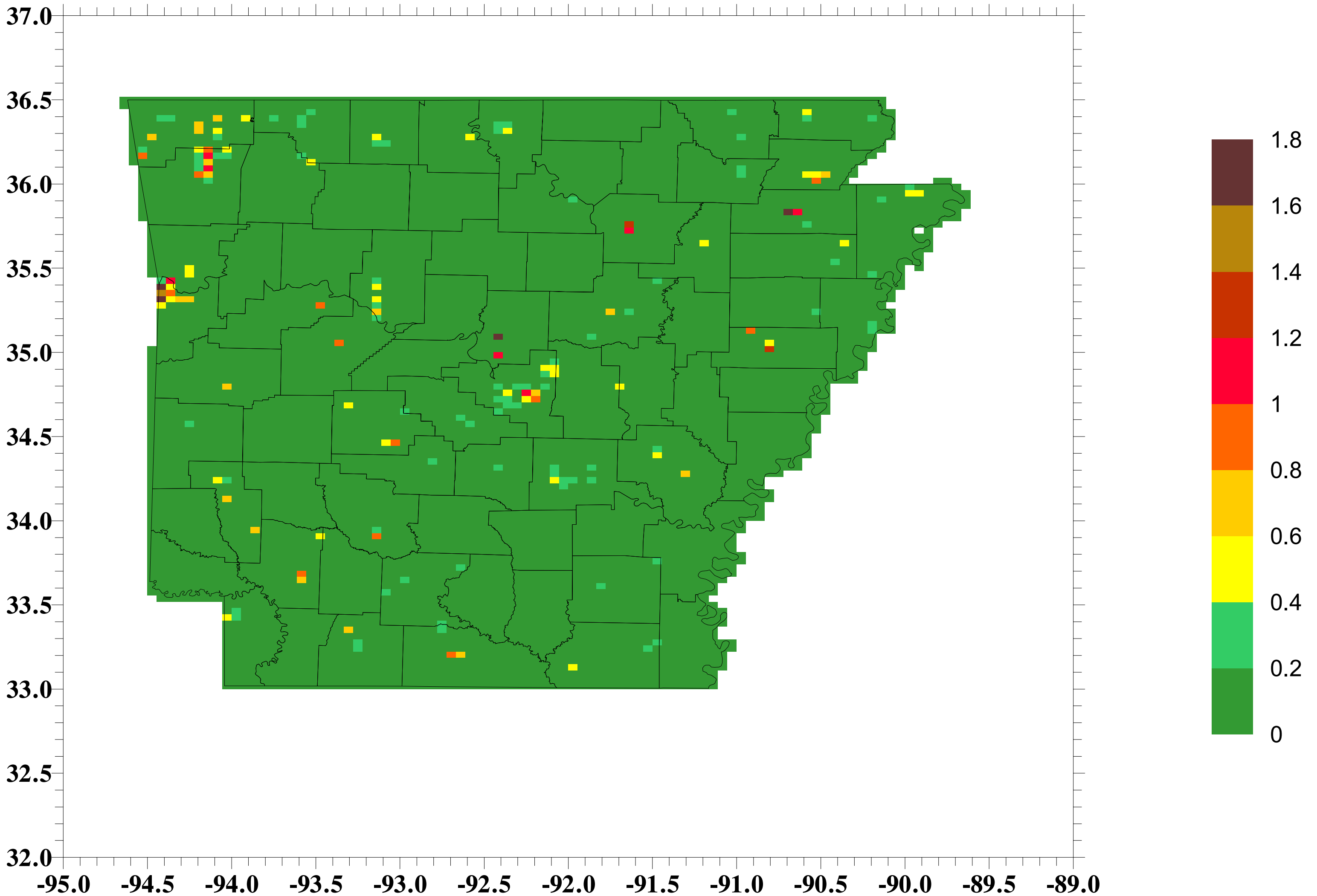


Figure 5-52.

Arkansas Area Sources Winter Weekday NH3 Emissions (tpd)

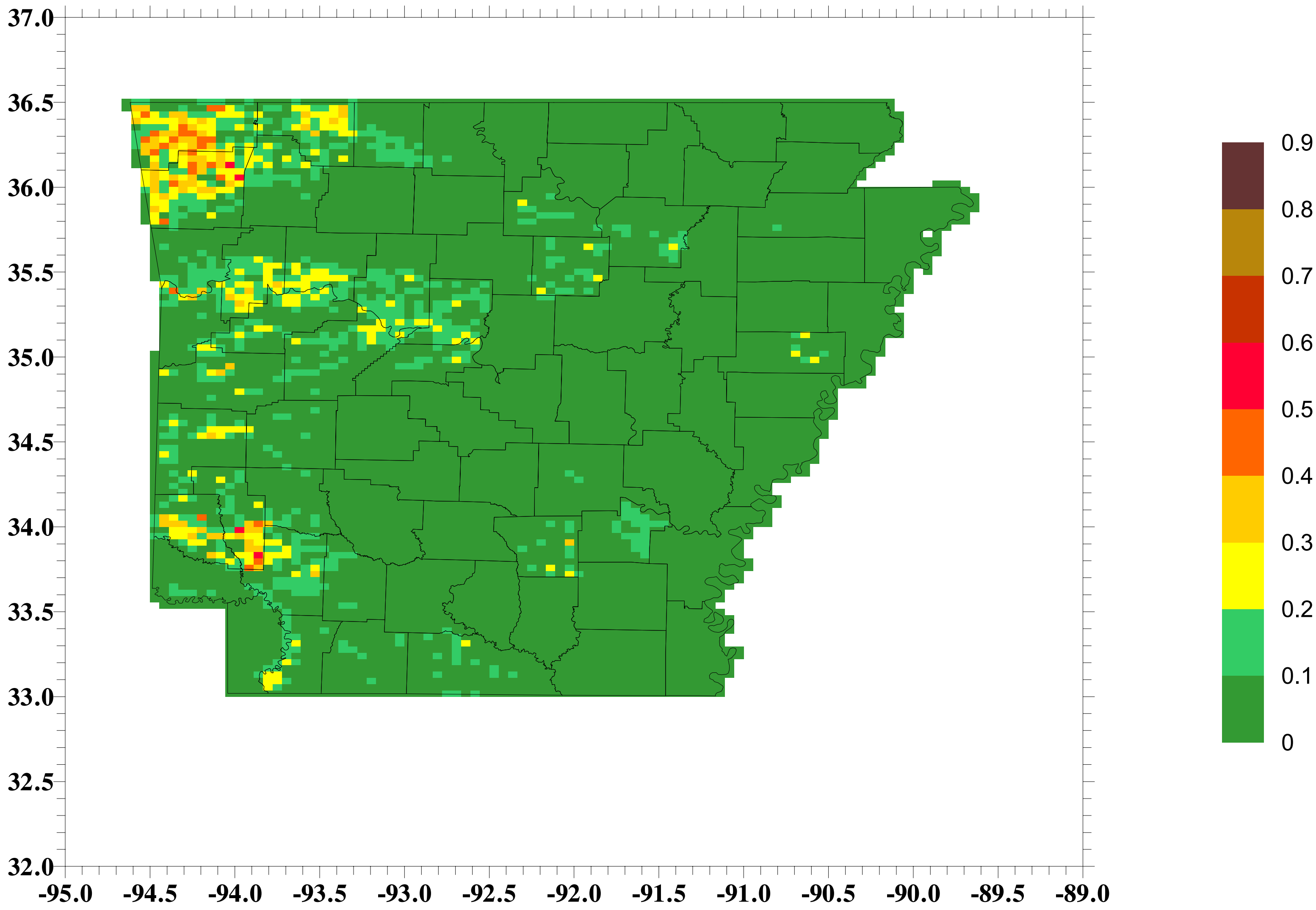


Figure 53.

Arkansas On-road Sources Winter Weekday VOC Emissions (tpd)

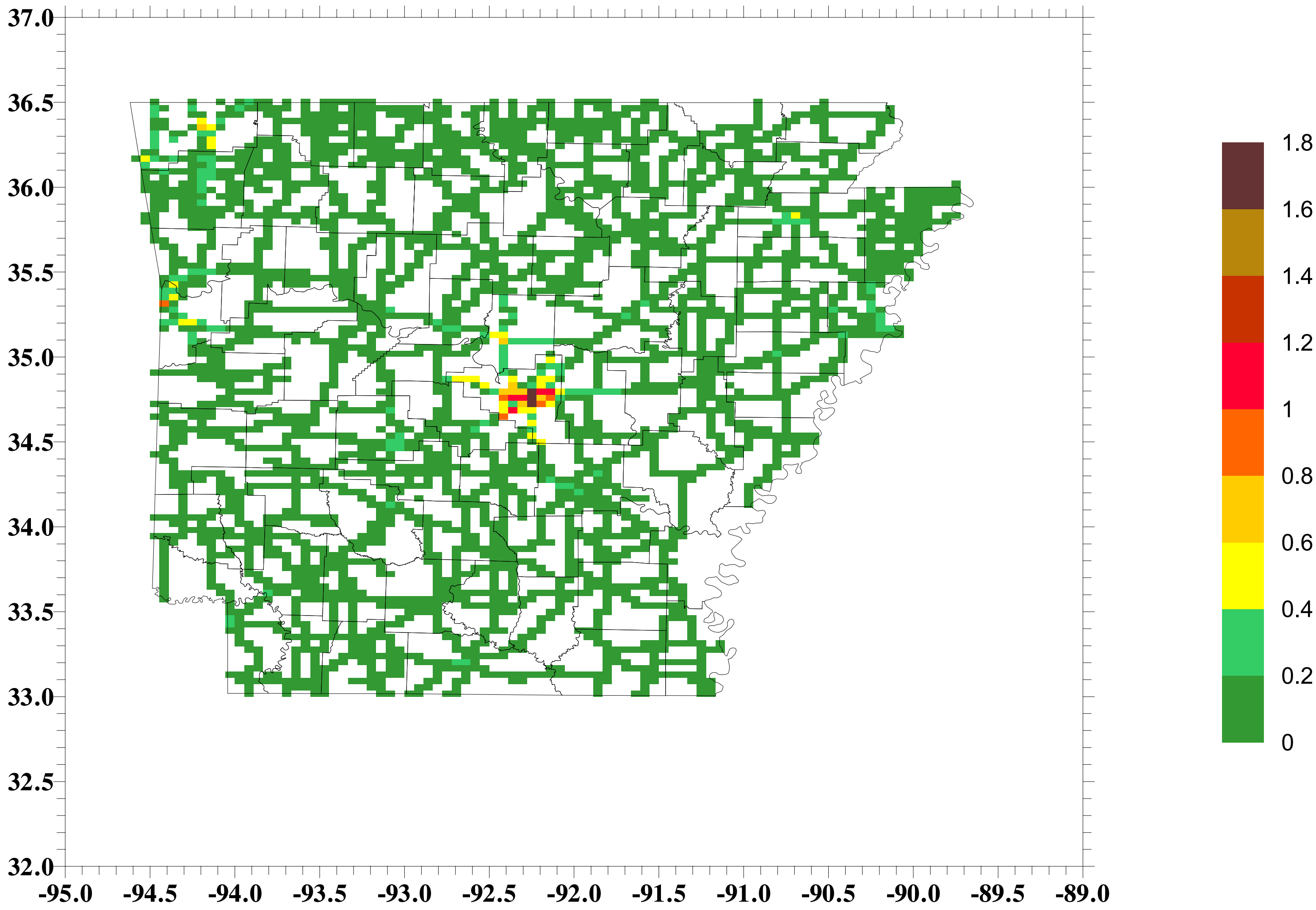


Figure 5-54.

Arkansas On-road Sources Winter Weekday NOx Emissions (tpd)

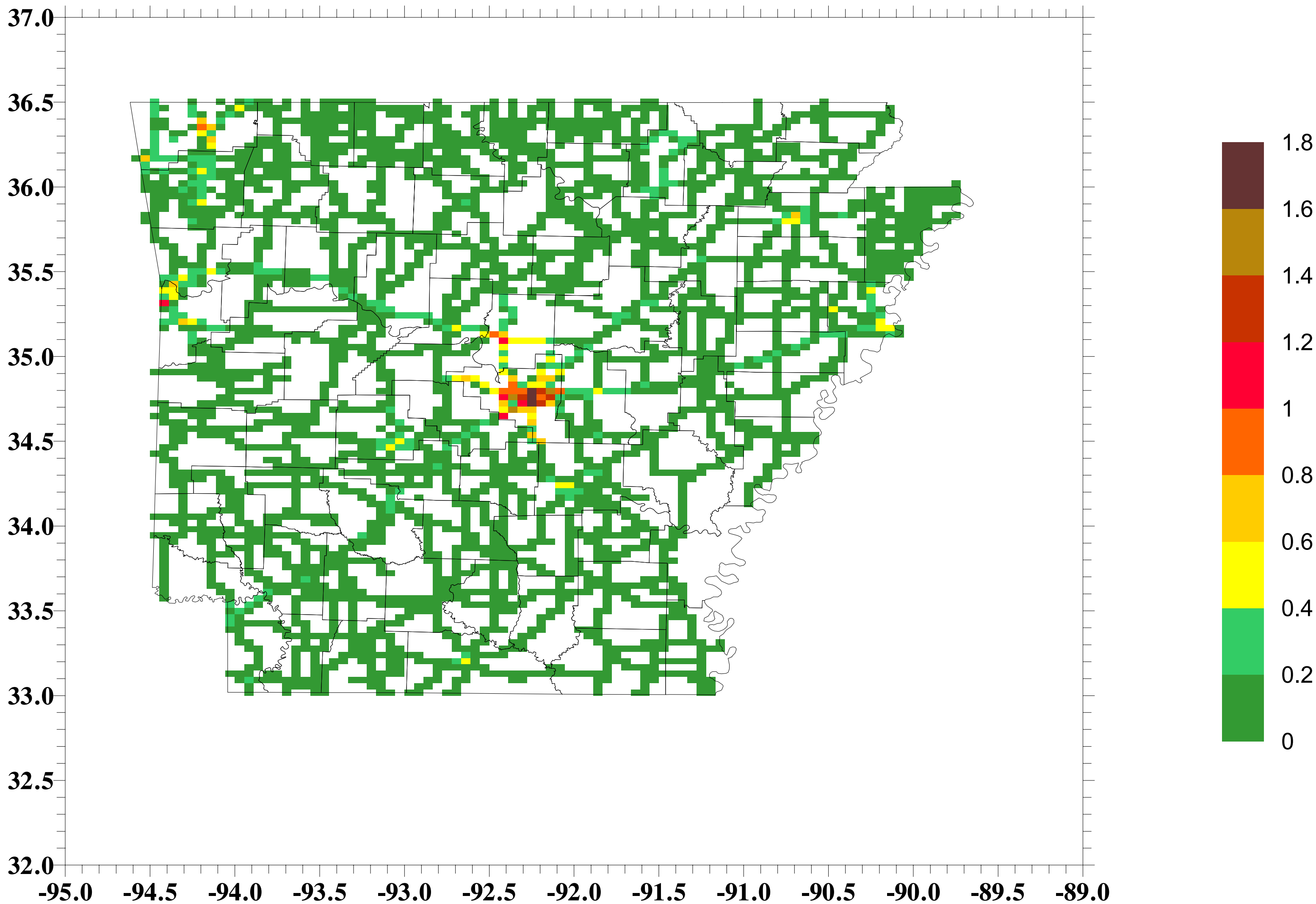


Figure 5-55.

Arkansas On-road Sources Winter Weekday CO Emissions (tpd)

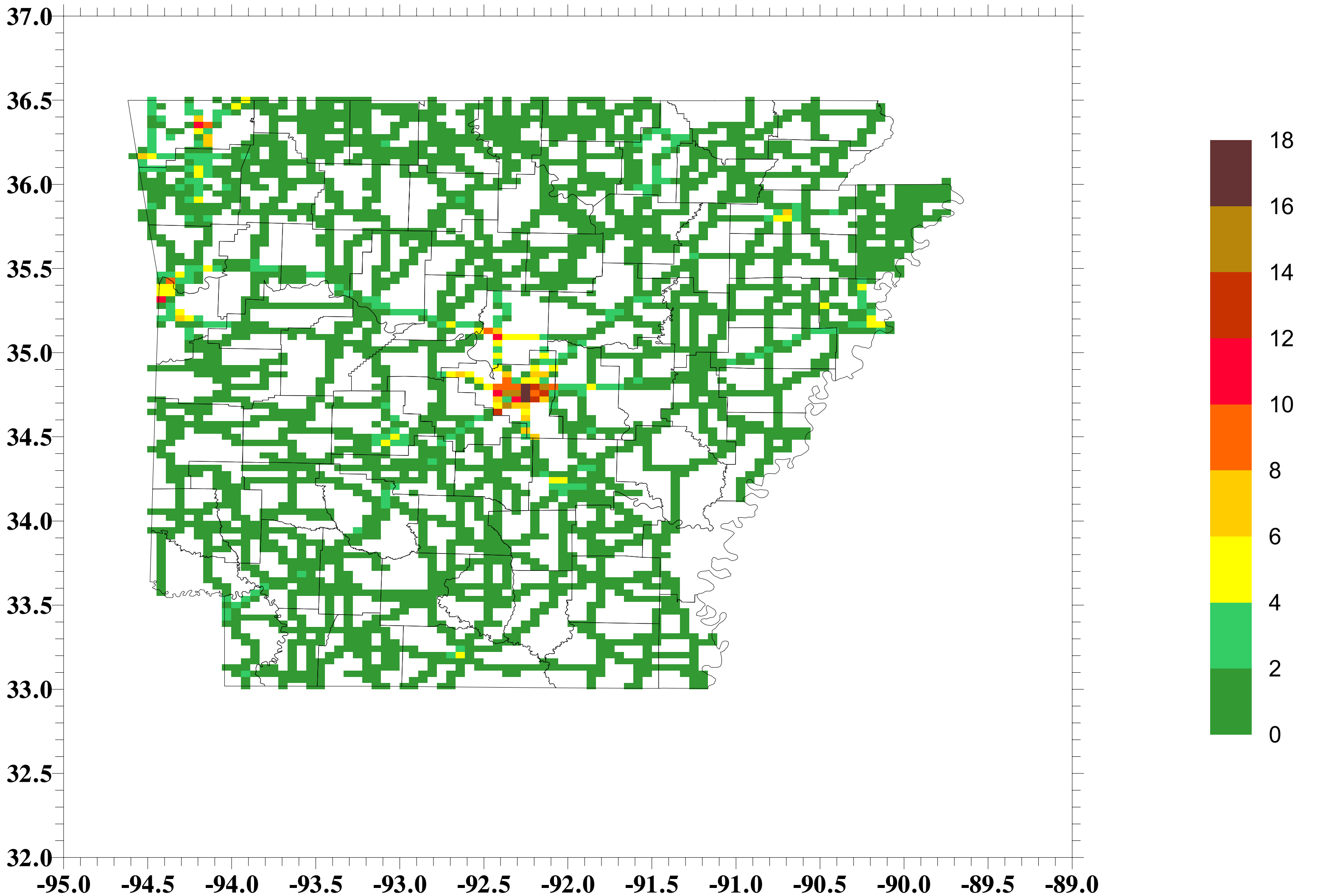


Figure 5-56.

Arkansas On-road Sources Winter Weekday PM10 Emissions (tpd)

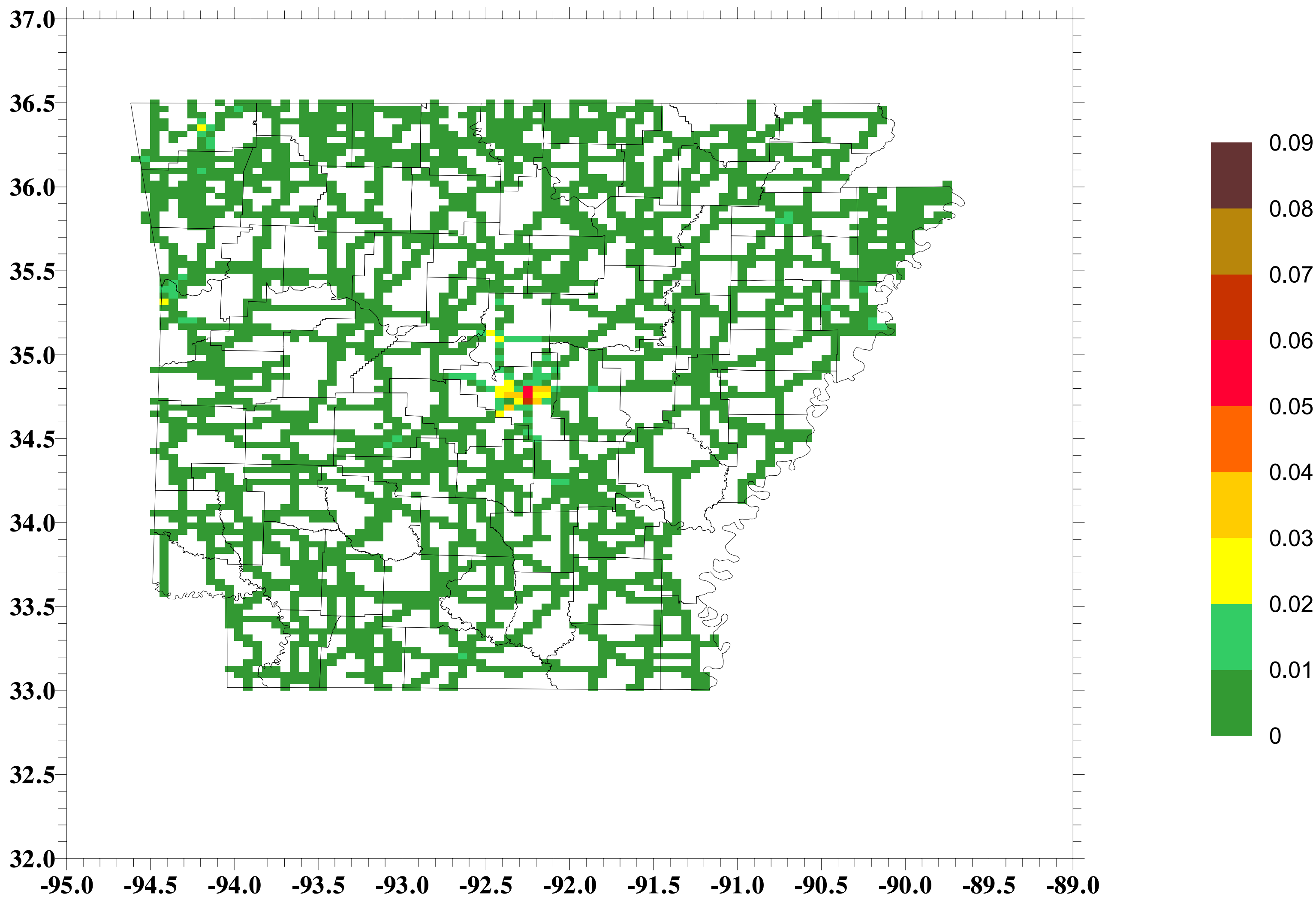


Figure 5-57.

Arkansas On-road Sources Winter Weekday PM2.5 Emissions (tpd)

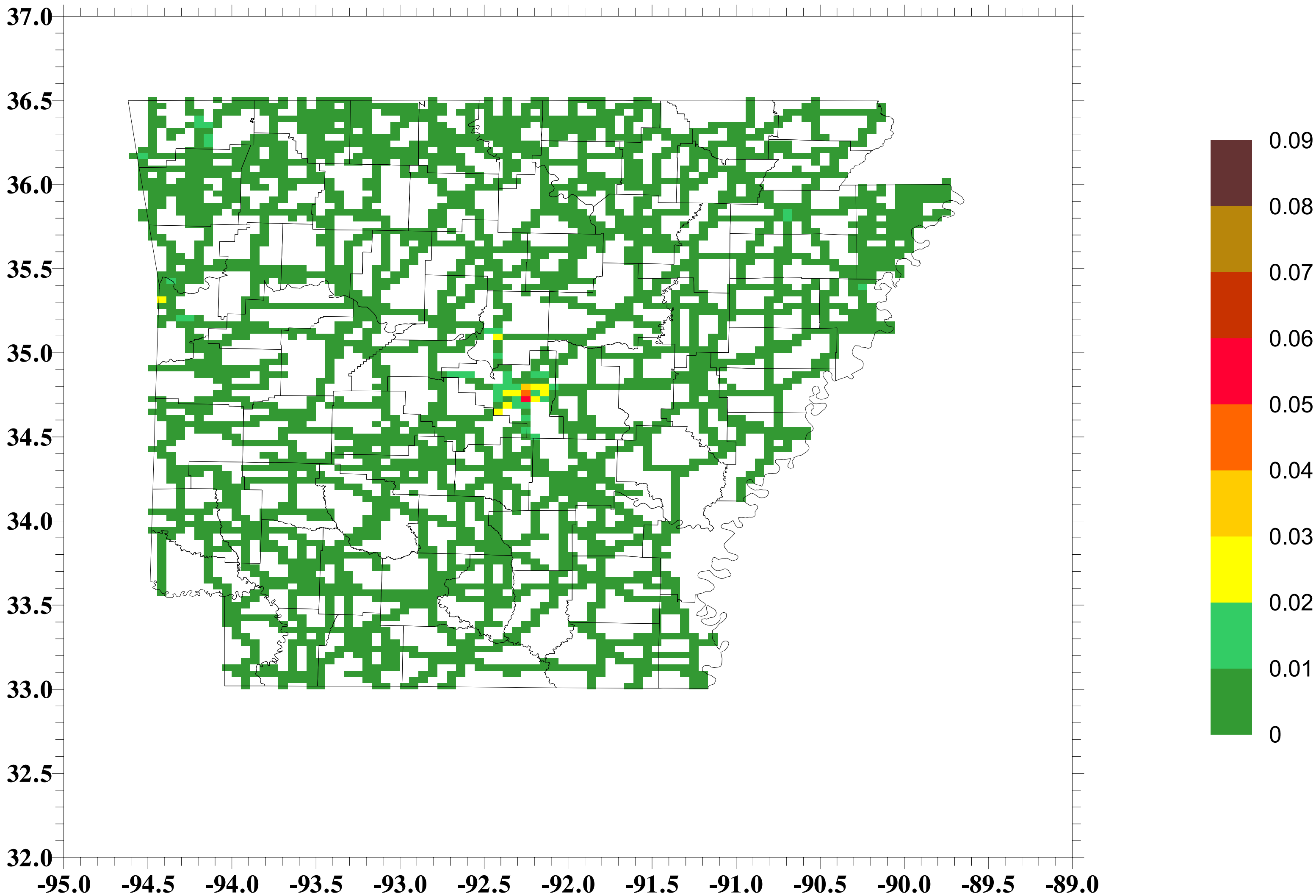


Figure 5-58.
Arkansas On-road Sources Winter Weekday SOx Emissions (tpd)

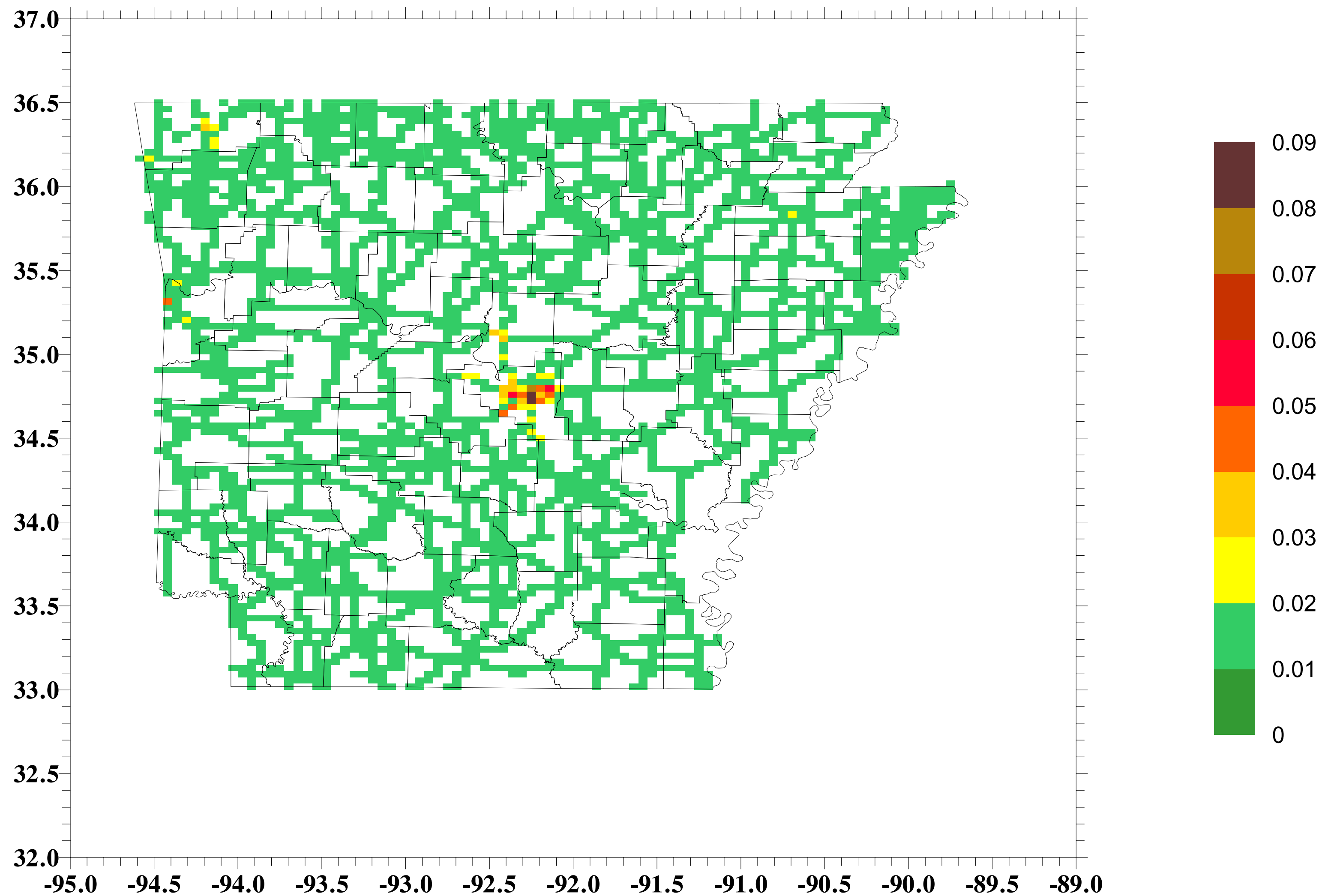


Figure 5-59.
Arkansas On-road Sources Winter Weekday NH3 Emissions (tpd)

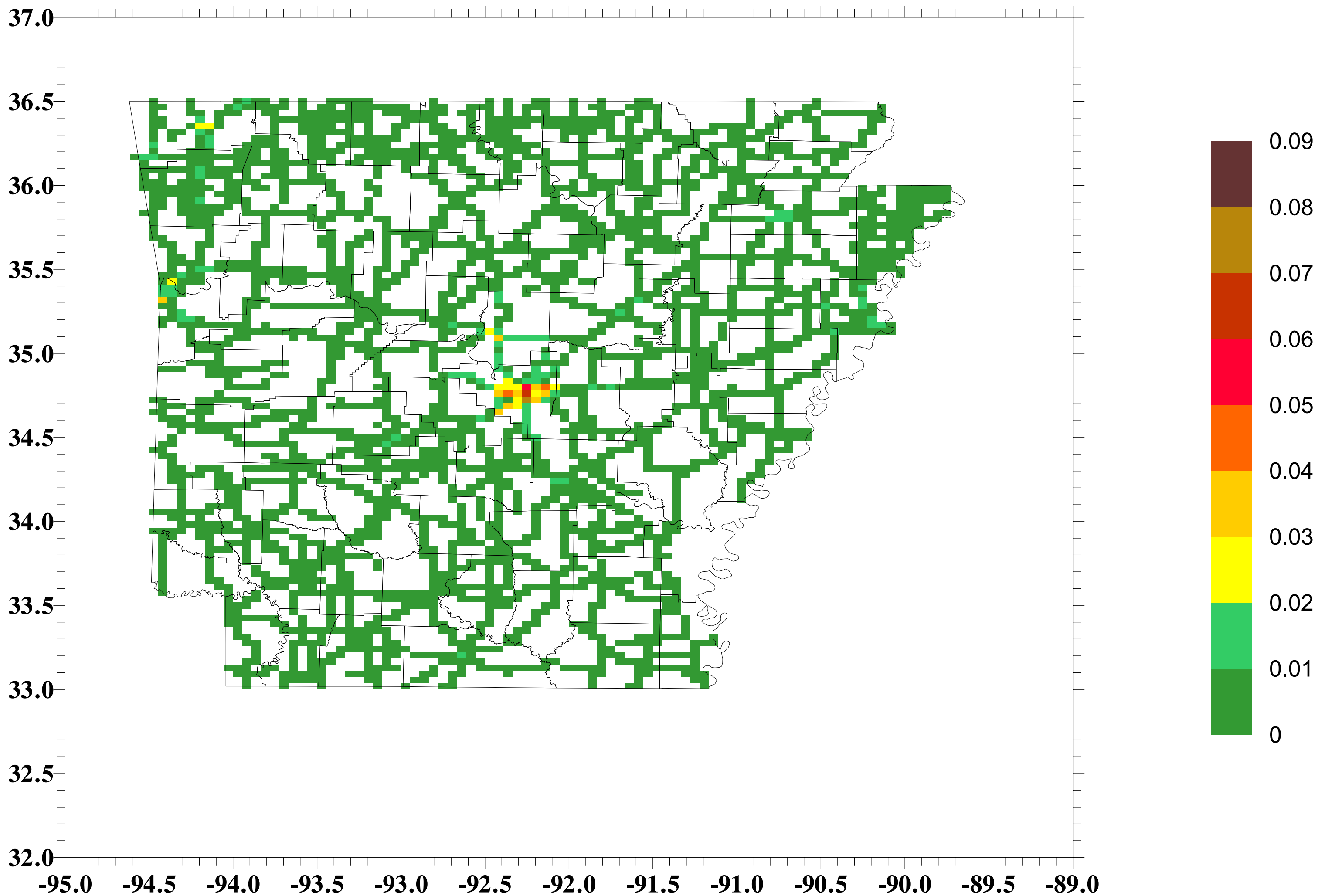


Figure 5-60.

Arkansas Off-road Sources Winter Weekday VOC Emissions (tpd)

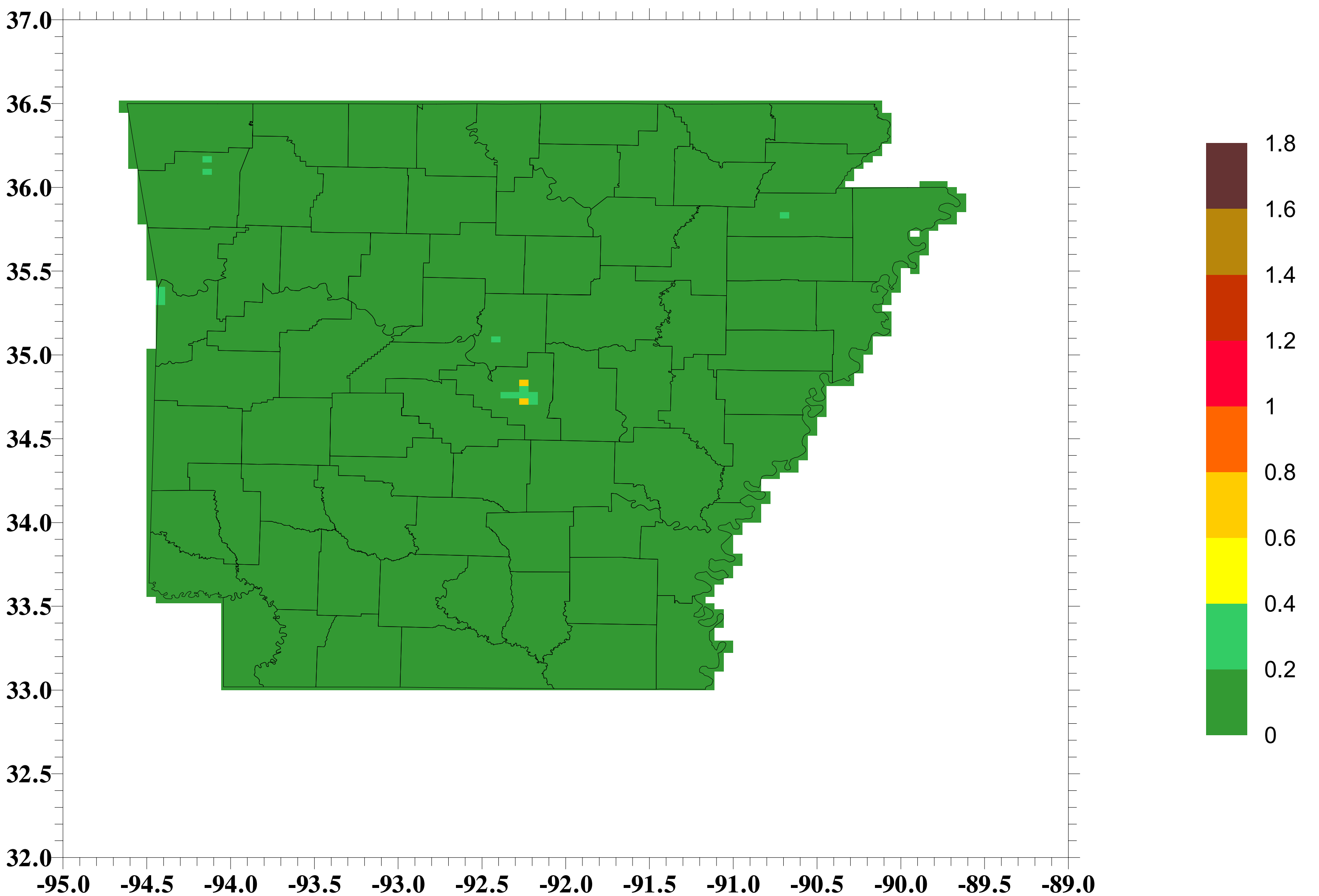


Figure 5-61.

Arkansas Off-road Sources Winter Weekday NOx Emissions (tpd)

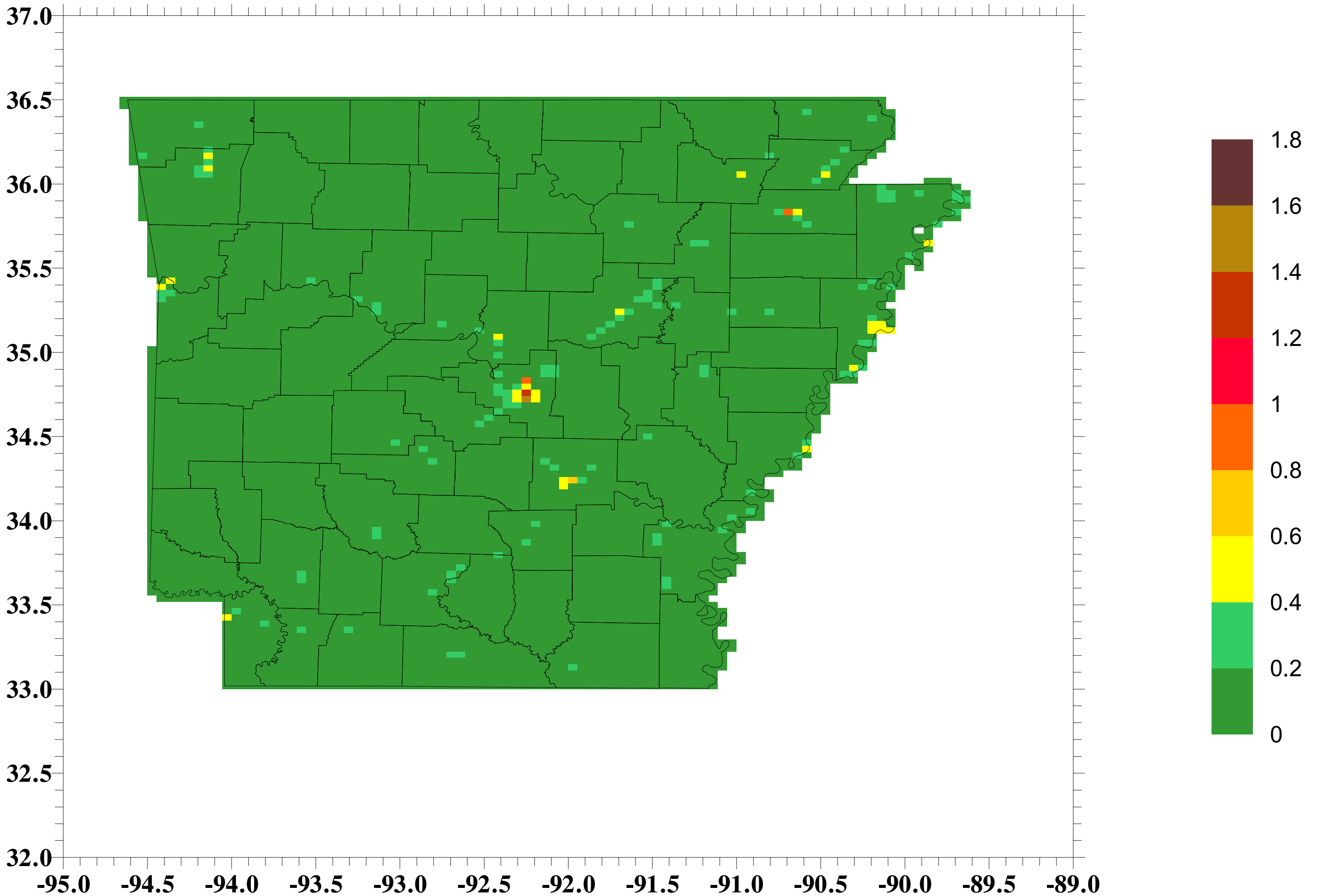


Figure 5-62.

Arkansas Off-road Sources Winter Weekday CO Emissions (tpd)

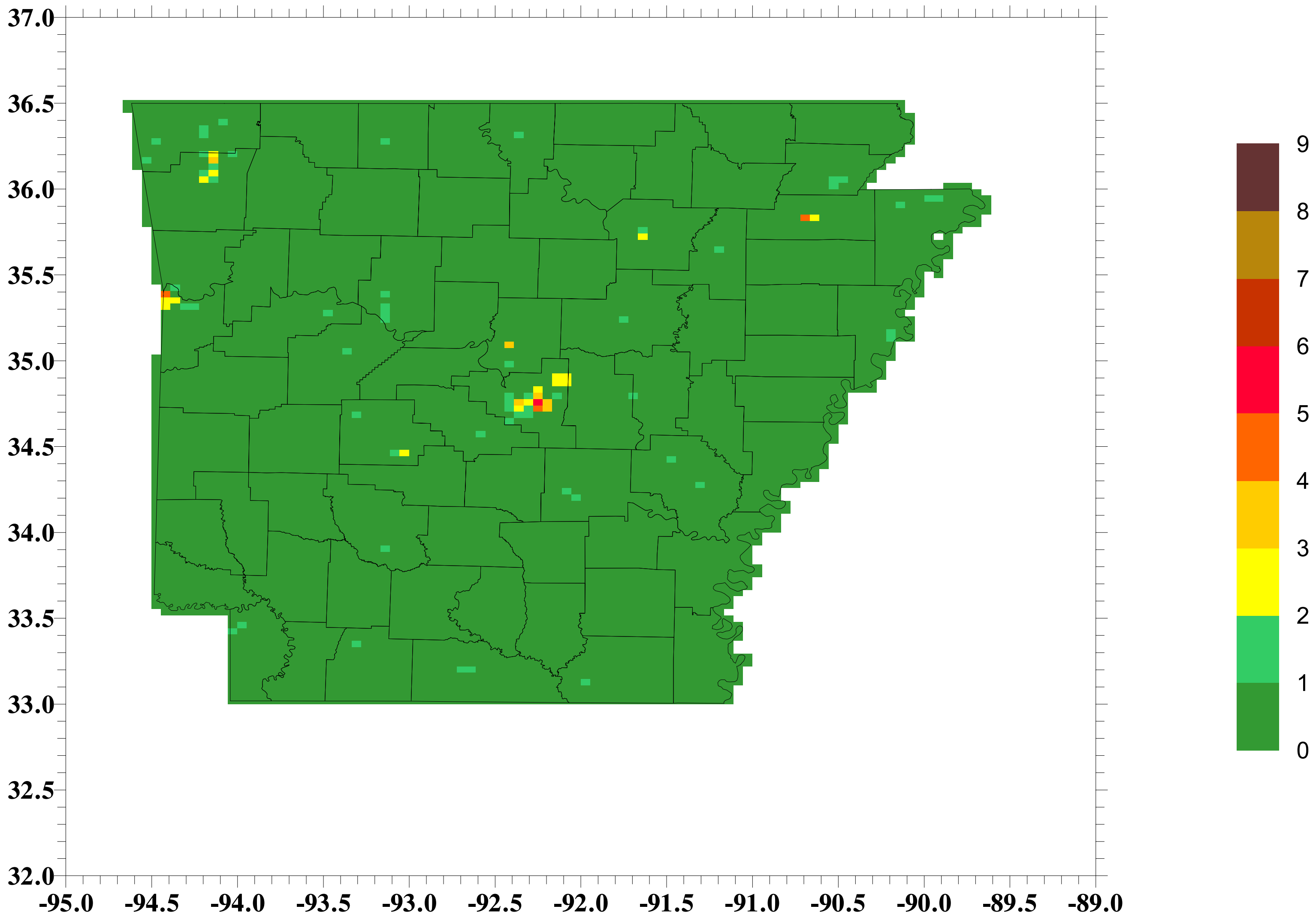


Figure 5-63.

Arkansas Off-road Sources Winter Weekday PM10 Emissions (tpd)

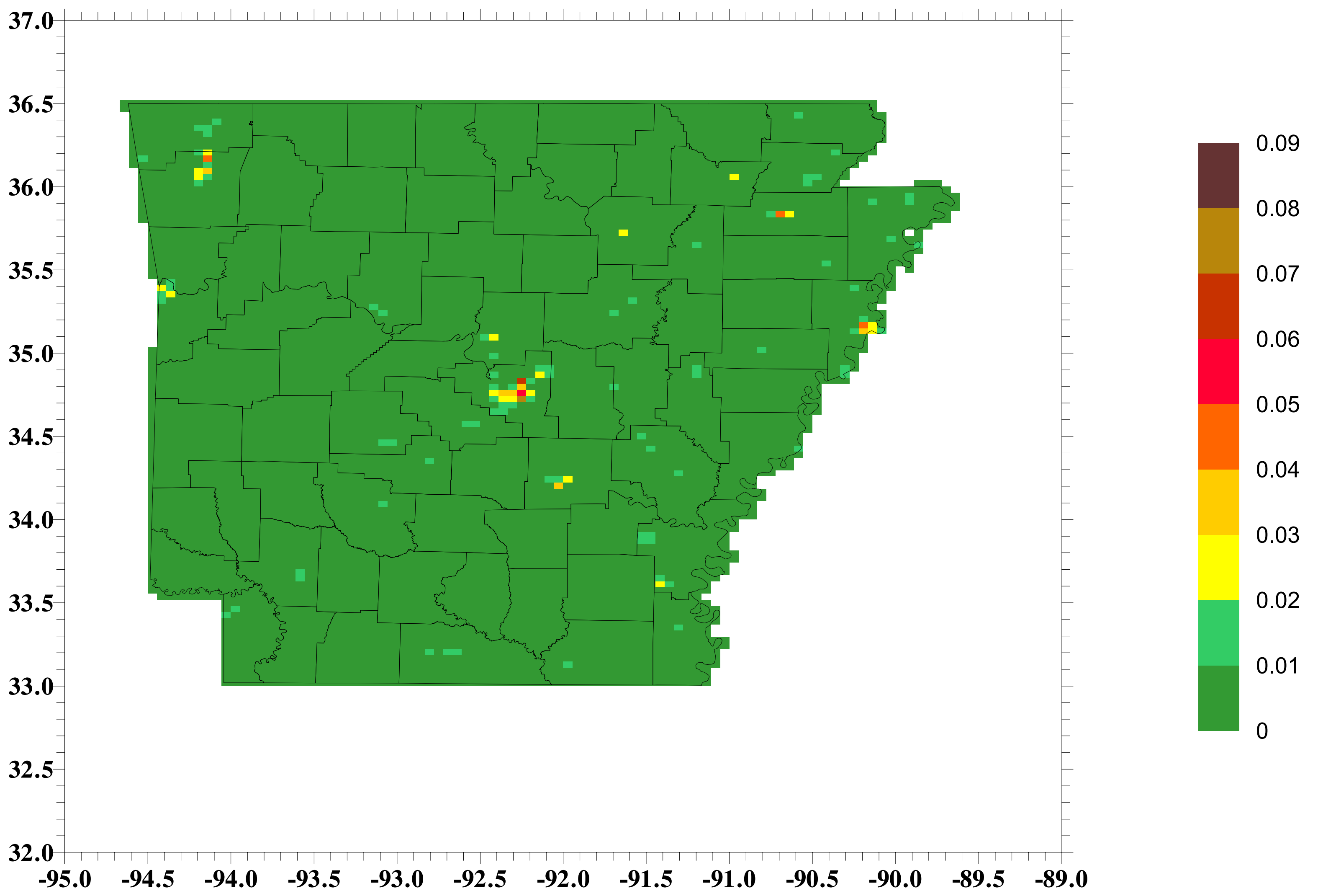


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Figure 5-64.
Arkansas Off-road Sources Winter Weekday PM2.5 Emissions (tpd)

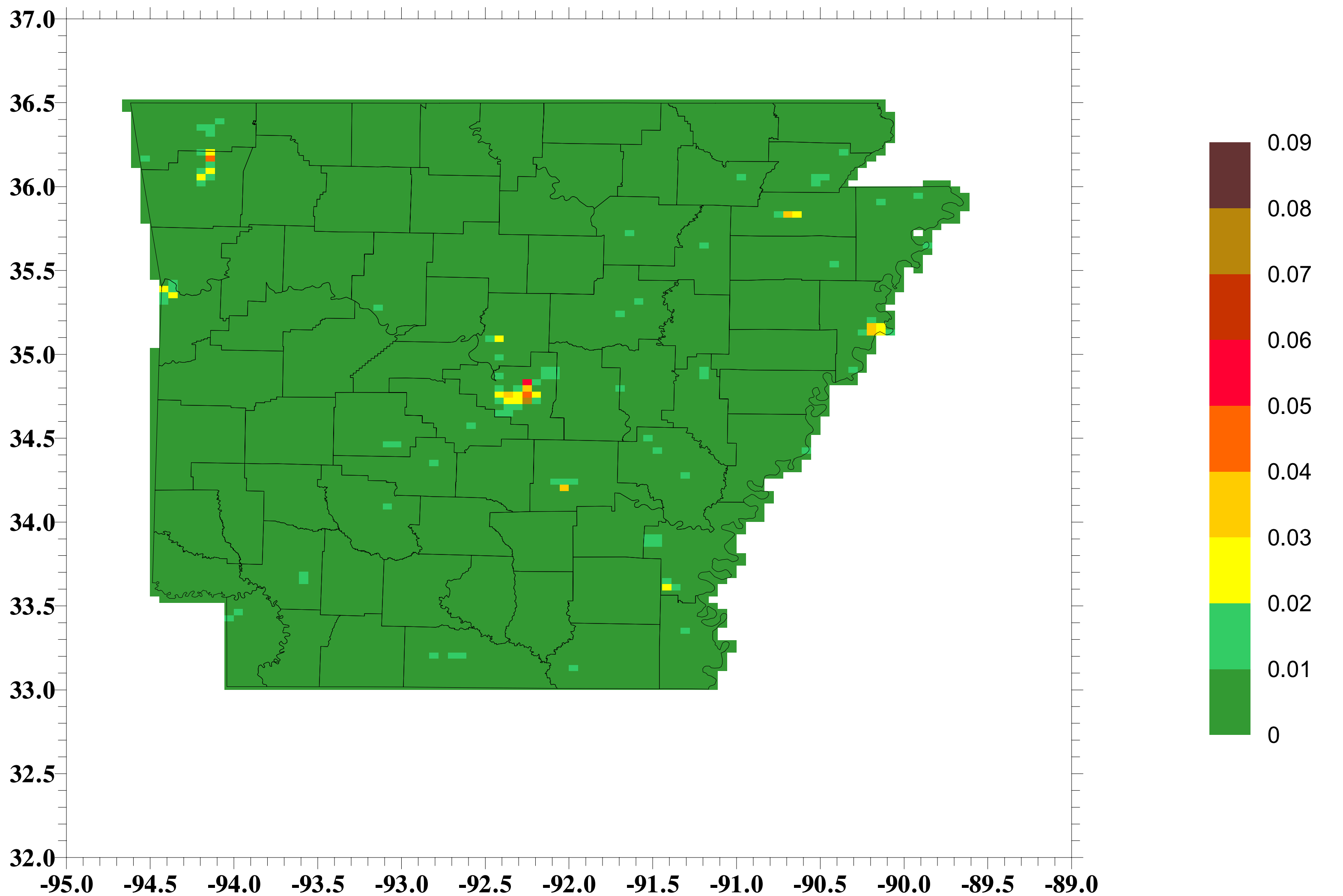


Figure 5-65.

Arkansas Off-road Sources Winter Weekday SOx Emissions (tpd)

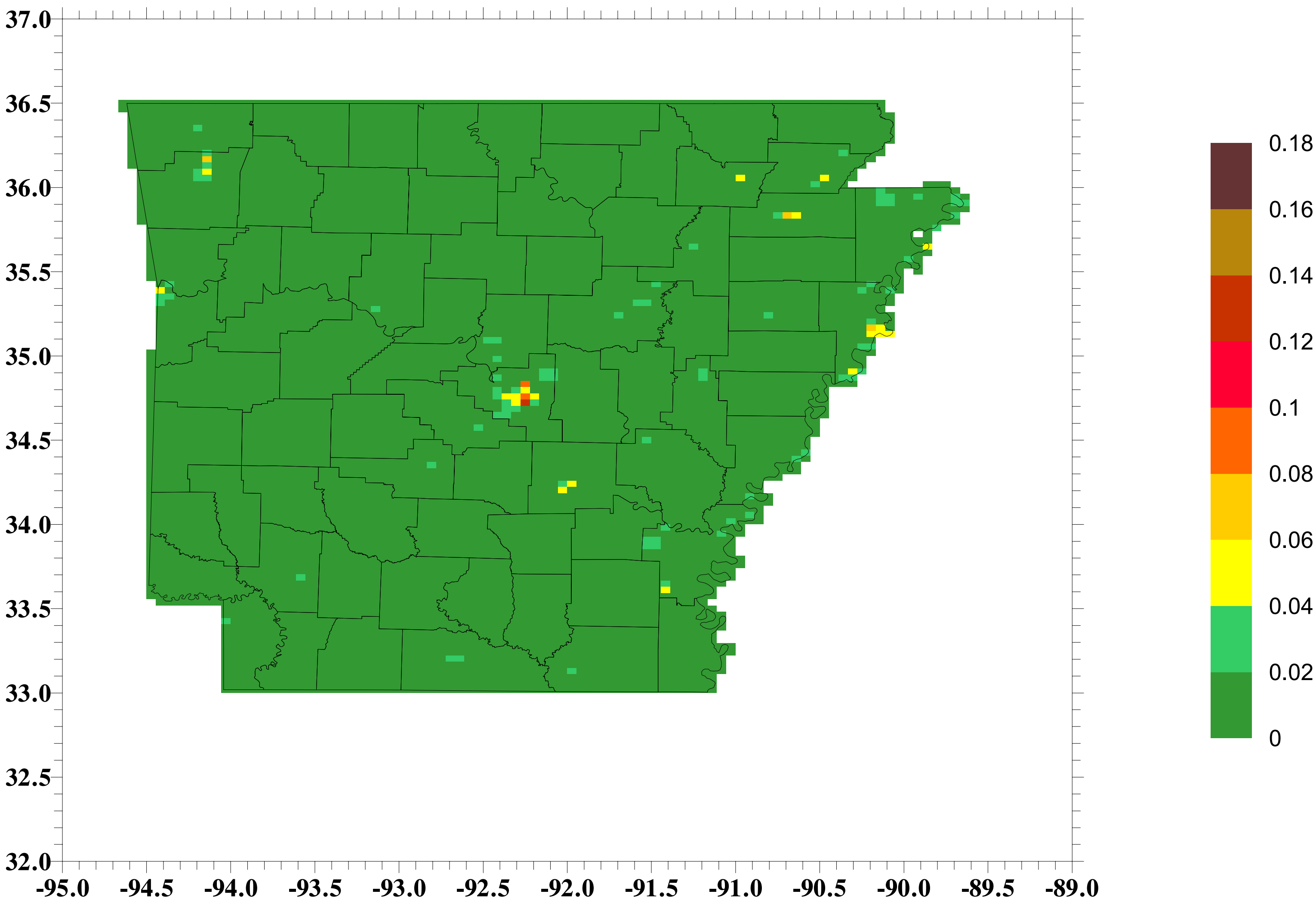
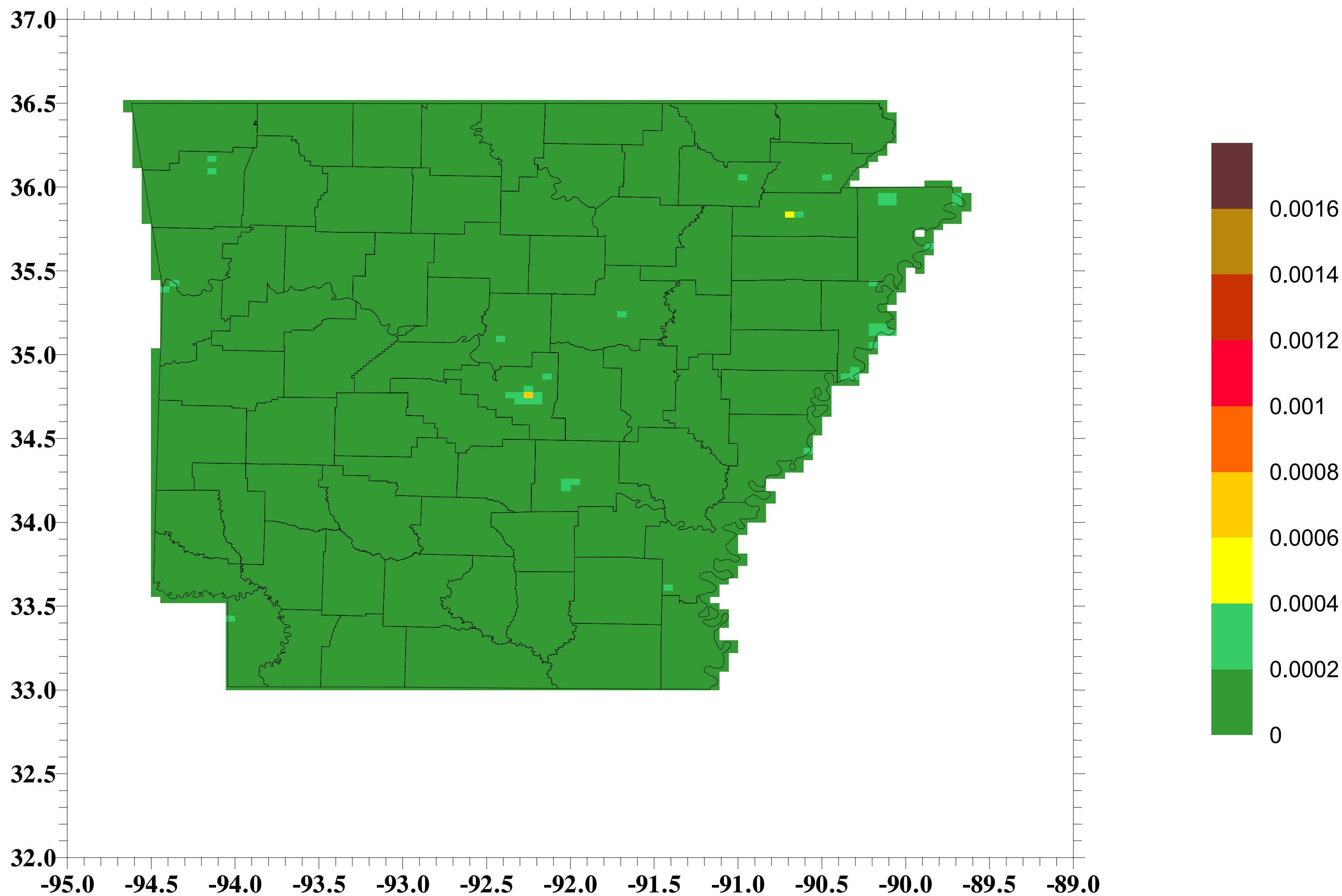


Figure 5-66.
Arkansas Off-road Sources Winter Weekday NH3 Emissions (tpd)



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Appendix A

Mobile Sources Emissions Modeling Inputs

Table A-1. NCDC Climatic Regions for Arkansas State.

Region	Description	County	FIPS
1	Northwest AR	Benton	05007
1	Northwest AR	Boone	05009
1	Northwest AR	Carroll	05015
1	Northwest AR	Madison	05087
1	Northwest AR	Newton	05101
1	Northwest AR	Washington	05143
2	North Central AR	Baxter	05005
2	North Central AR	Cleburne	05023
2	North Central AR	Fulton	05049
2	North Central AR	Izard	05065
2	North Central AR	Marion	05089
2	North Central AR	Searcy	05129
2	North Central AR	Sharp	05135
2	North Central AR	Stone	05137
2	North Central AR	Van Buren	05141
3	Northeast AR	Clay	05021
3	Northeast AR	Craighead	05031
3	Northeast AR	Greene	05055
3	Northeast AR	Independence	05063
3	Northeast AR	Jackson	05067
3	Northeast AR	Lawrence	05075
3	Northeast AR	Mississippi	05093
3	Northeast AR	Poinsett	05111
3	Northeast AR	Randolph	05121
3	Northeast AR	White	05145
4	West Central AR	Crawford	05033
4	West Central AR	Franklin	05047
4	West Central AR	Johnson	05071
4	West Central AR	Logan	05083
4	West Central AR	Polk	05113
4	West Central AR	Scott	05127
4	West Central AR	Sebastian	05131
5	Central AR	Conway	05029
5	Central AR	Faulkner	05045
5	Central AR	Garland	05051
5	Central AR	Grant	05053
5	Central AR	Hot Spring	05059
5	Central AR	Perry	05105
5	Central AR	Pope	05115
5	Central AR	Pulaski	05119
5	Central AR	Saline	05125
5	Central AR	Yell	05149
6	East Central AR	Arkansas	05001
6	East Central AR	Crittenden	05035
6	East Central AR	Cross	05037
6	East Central AR	Lee	05077

Region	Description	County	FIPS
6	East Central AR	Lonoke	05085
6	East Central AR	Monroe	05095
6	East Central AR	Phillips	05107
6	East Central AR	Prairie	05117
6	East Central AR	St. Francis	05123
6	East Central AR	Woodruff	05147
7	Southwest AR	Hempstead	05057
7	Southwest AR	Howard	05061
7	Southwest AR	Lafayette	05073
7	Southwest AR	Little River	05081
7	Southwest AR	Miller	05091
7	Southwest AR	Montgomery	05097
7	Southwest AR	Pike	05109
7	Southwest AR	Sevier	05133
8	South Central AR	Bradley	05011
8	South Central AR	Calhoun	05013
8	South Central AR	Clark	05019
8	South Central AR	Cleveland	05025
8	South Central AR	Columbia	05027
8	South Central AR	Dallas	05039
8	South Central AR	Nevada	05099
8	South Central AR	Ouachita	05103
8	South Central AR	Union	05139
9	Southeast AR	Ashley	05003
9	Southeast AR	Chicot	05017
9	Southeast AR	Desha	05041
9	Southeast AR	Drew	05043
9	Southeast AR	Jefferson	05069
9	Southeast AR	Lincoln	05079

Table A-2. Arkansas 2002 Nonroad Inputs by County and Season.

AR State Counties	FIPS Code	Season	RVP (psi)	Gasoline Sulfur (%)	Diesel Sulfur (%)	CNG/LPG Sulfur (%)	Max. Temp. (F)	Min. Temp. (F)
Arkansas	05001	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Ashley	05003	autumn	10.6	0.03	0.34	0.003	73.1	55.5
Baxter	05005	autumn	10.6	0.03	0.34	0.003	68.3	49.7
Benton	05007	autumn	10.6	0.03	0.34	0.003	73.0	41.6
Boone	05009	autumn	10.6	0.03	0.34	0.003	73.0	41.6
Bradley	05011	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Calhoun	05013	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Carroll	05015	autumn	10.6	0.03	0.34	0.003	73.0	41.6
Chicot	05017	autumn	10.6	0.03	0.34	0.003	73.1	55.5
Clark	05019	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Clay	05021	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Cleburne	05023	autumn	10.6	0.03	0.34	0.003	68.3	49.7
Cleveland	05025	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Columbia	05027	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Conway	05029	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Craighead	05031	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Crawford	05033	autumn	10.6	0.03	0.34	0.003	72.1	49.1
Crittenden	05035	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Cross	05037	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Dallas	05039	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Desha	05041	autumn	10.6	0.03	0.34	0.003	73.1	55.5
Drew	05043	autumn	10.6	0.03	0.34	0.003	73.1	55.5
Faulkner	05045	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Franklin	05047	autumn	10.6	0.03	0.34	0.003	72.1	49.1
Fulton	05049	autumn	10.6	0.03	0.34	0.003	68.3	49.7
Garland	05051	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Grant	05053	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Greene	05055	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Hempstead	05057	autumn	10.6	0.03	0.34	0.003	73.1	52.5
Hot Spring	05059	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Howard	05061	autumn	10.6	0.03	0.34	0.003	73.1	52.5
Independence	05063	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Izard	05065	autumn	10.6	0.03	0.34	0.003	68.3	49.7
Jackson	05067	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Jefferson	05069	autumn	10.6	0.03	0.34	0.003	73.1	55.5
Johnson	05071	autumn	10.6	0.03	0.34	0.003	72.1	49.1
Lafayette	05073	autumn	10.6	0.03	0.34	0.003	73.1	52.5
Lawrence	05075	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Lee	05077	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Lincoln	05079	autumn	10.6	0.03	0.34	0.003	73.1	55.5
Little River	05081	autumn	10.6	0.03	0.34	0.003	73.1	52.5
Logan	05083	autumn	10.6	0.03	0.34	0.003	72.1	49.1
Lonoke	05085	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Madison	05087	autumn	10.6	0.03	0.34	0.003	73.0	41.6
Marion	05089	autumn	10.6	0.03	0.34	0.003	68.3	49.7

AR State Counties	FIPS Code	Season	RVP (psi)	Gasoline Sulfur (%)	Diesel Sulfur (%)	CNG/LPG Sulfur (%)	Max. Temp. (F)	Min. Temp. (F)
Miller	05091	autumn	10.6	0.03	0.34	0.003	73.1	52.5
Mississippi	05093	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Monroe	05095	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Montgomery	05097	autumn	10.6	0.03	0.34	0.003	73.1	52.5
Nevada	05099	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Newton	05101	autumn	10.6	0.03	0.34	0.003	73.0	41.6
Ouachita	05103	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Perry	05105	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Phillips	05107	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Pike	05109	autumn	10.6	0.03	0.34	0.003	73.1	52.5
Poinsett	05111	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Polk	05113	autumn	10.6	0.03	0.34	0.003	72.1	49.1
Pope	05115	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Prairie	05117	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Pulaski	05119	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Randolph	05121	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Saline	05125	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Scott	05127	autumn	10.6	0.03	0.34	0.003	72.1	49.1
Searcy	05129	autumn	10.6	0.03	0.34	0.003	68.3	49.7
Sebastian	05131	autumn	10.6	0.03	0.34	0.003	72.1	49.1
Sevier	05133	autumn	10.6	0.03	0.34	0.003	73.1	52.5
Sharp	05135	autumn	10.6	0.03	0.34	0.003	68.3	49.7
St. Francis	05123	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Stone	05137	autumn	10.6	0.03	0.34	0.003	68.3	49.7
Union	05139	autumn	10.6	0.03	0.34	0.003	74.6	51.1
Van Buren	05141	autumn	10.6	0.03	0.34	0.003	68.3	49.7
Washington	05143	autumn	10.6	0.03	0.34	0.003	73.0	41.6
White	05145	autumn	10.6	0.03	0.34	0.003	69.2	51.7
Woodruff	05147	autumn	10.6	0.03	0.34	0.003	73.3	51.2
Yell	05149	autumn	10.6	0.03	0.34	0.003	72.4	54.7
Arkansas	05001	spring	8.9	0.03	0.34	0.003	73.2	48.4
Ashley	05003	spring	8.9	0.03	0.34	0.003	75.1	50.0
Baxter	05005	spring	8.9	0.03	0.34	0.003	68.5	45.7
Benton	05007	spring	8.9	0.03	0.34	0.003	73.4	37.6
Boone	05009	spring	8.9	0.03	0.34	0.003	73.4	37.6
Bradley	05011	spring	8.9	0.03	0.34	0.003	76.1	46.4
Calhoun	05013	spring	8.9	0.03	0.34	0.003	76.1	46.4
Carroll	05015	spring	8.9	0.03	0.34	0.003	73.4	37.6
Chicot	05017	spring	8.9	0.03	0.34	0.003	75.1	50.0
Clark	05019	spring	8.9	0.03	0.34	0.003	76.1	46.4
Clay	05021	spring	8.9	0.03	0.34	0.003	68.9	48.7
Cleburne	05023	spring	8.9	0.03	0.34	0.003	68.5	45.7
Cleveland	05025	spring	8.9	0.03	0.34	0.003	76.1	46.4
Columbia	05027	spring	8.9	0.03	0.34	0.003	76.1	46.4
Conway	05029	spring	8.9	0.03	0.34	0.003	72.8	53.0

AR State Counties	FIPS Code	Season	RVP (psi)	Gasoline Sulfur (%)	Diesel Sulfur (%)	CNG/LPG Sulfur (%)	Max. Temp. (F)	Min. Temp. (F)
Craighead	05031	spring	8.9	0.03	0.34	0.003	68.9	48.7
Crawford	05033	spring	8.9	0.03	0.34	0.003	72.5	45.1
Crittenden	05035	spring	8.9	0.03	0.34	0.003	73.2	48.4
Cross	05037	spring	8.9	0.03	0.34	0.003	73.2	48.4
Dallas	05039	spring	8.9	0.03	0.34	0.003	76.1	46.4
Desha	05041	spring	8.9	0.03	0.34	0.003	75.1	50.0
Drew	05043	spring	8.9	0.03	0.34	0.003	75.1	50.0
Faulkner	05045	spring	8.9	0.03	0.34	0.003	72.8	53.0
Franklin	05047	spring	8.9	0.03	0.34	0.003	72.5	45.1
Fulton	05049	spring	8.9	0.03	0.34	0.003	68.5	45.7
Garland	05051	spring	8.9	0.03	0.34	0.003	72.8	53.0
Grant	05053	spring	8.9	0.03	0.34	0.003	72.8	53.0
Greene	05055	spring	8.9	0.03	0.34	0.003	68.9	48.7
Hempstead	05057	spring	8.9	0.03	0.34	0.003	73.5	48.7
Hot Spring	05059	spring	8.9	0.03	0.34	0.003	72.8	53.0
Howard	05061	spring	8.9	0.03	0.34	0.003	73.5	48.7
Independence	05063	spring	8.9	0.03	0.34	0.003	68.9	48.7
Izard	05065	spring	8.9	0.03	0.34	0.003	68.5	45.7
Jackson	05067	spring	8.9	0.03	0.34	0.003	68.9	48.7
Jefferson	05069	spring	8.9	0.03	0.34	0.003	75.1	50.0
Johnson	05071	spring	8.9	0.03	0.34	0.003	72.5	45.1
Lafayette	05073	spring	8.9	0.03	0.34	0.003	73.5	48.7
Lawrence	05075	spring	8.9	0.03	0.34	0.003	68.9	48.7
Lee	05077	spring	8.9	0.03	0.34	0.003	73.2	48.4
Lincoln	05079	spring	8.9	0.03	0.34	0.003	75.1	50.0
Little River	05081	spring	8.9	0.03	0.34	0.003	73.5	48.7
Logan	05083	spring	8.9	0.03	0.34	0.003	72.5	45.1
Lonoke	05085	spring	8.9	0.03	0.34	0.003	73.2	48.4
Madison	05087	spring	8.9	0.03	0.34	0.003	73.4	37.6
Marion	05089	spring	8.9	0.03	0.34	0.003	68.5	45.7
Miller	05091	spring	8.9	0.03	0.34	0.003	73.5	48.7
Mississippi	05093	spring	8.9	0.03	0.34	0.003	68.9	48.7
Monroe	05095	spring	8.9	0.03	0.34	0.003	73.2	48.4
Montgomery	05097	spring	8.9	0.03	0.34	0.003	73.5	48.7
Nevada	05099	spring	8.9	0.03	0.34	0.003	76.1	46.4
Newton	05101	spring	8.9	0.03	0.34	0.003	73.4	37.6
Ouachita	05103	spring	8.9	0.03	0.34	0.003	76.1	46.4
Perry	05105	spring	8.9	0.03	0.34	0.003	72.8	53.0
Phillips	05107	spring	8.9	0.03	0.34	0.003	73.2	48.4
Pike	05109	spring	8.9	0.03	0.34	0.003	73.5	48.7
Poinsett	05111	spring	8.9	0.03	0.34	0.003	68.9	48.7
Polk	05113	spring	8.9	0.03	0.34	0.003	72.5	45.1
Pope	05115	spring	8.9	0.03	0.34	0.003	72.8	53.0
Prairie	05117	spring	8.9	0.03	0.34	0.003	73.2	48.4
Pulaski	05119	spring	8.9	0.03	0.34	0.003	72.8	53.0

AR State Counties	FIPS Code	Season	RVP (psi)	Gasoline Sulfur (%)	Diesel Sulfur (%)	CNG/LPG Sulfur (%)	Max. Temp. (F)	Min. Temp. (F)
Randolph	05121	spring	8.9	0.03	0.34	0.003	68.9	48.7
Saline	05125	spring	8.9	0.03	0.34	0.003	72.8	53.0
Scott	05127	spring	8.9	0.03	0.34	0.003	72.5	45.1
Searcy	05129	spring	8.9	0.03	0.34	0.003	68.5	45.7
Sebastian	05131	spring	8.9	0.03	0.34	0.003	72.5	45.1
Sevier	05133	spring	8.9	0.03	0.34	0.003	73.5	48.7
Sharp	05135	spring	8.9	0.03	0.34	0.003	68.5	45.7
St. Francis	05123	spring	8.9	0.03	0.34	0.003	73.2	48.4
Stone	05137	spring	8.9	0.03	0.34	0.003	68.5	45.7
Union	05139	spring	8.9	0.03	0.34	0.003	76.1	46.4
Van Buren	05141	spring	8.9	0.03	0.34	0.003	68.5	45.7
Washington	05143	spring	8.9	0.03	0.34	0.003	73.4	37.6
White	05145	spring	8.9	0.03	0.34	0.003	68.9	48.7
Woodruff	05147	spring	8.9	0.03	0.34	0.003	73.2	48.4
Yell	05149	spring	8.9	0.03	0.34	0.003	72.8	53.0
Arkansas	05001	summer	7.6	0.03	0.34	0.003	92.9	67.9
Ashley	05003	summer	7.6	0.03	0.34	0.003	92.8	68.8
Baxter	05005	summer	7.6	0.03	0.34	0.003	89.3	65.4
Benton	05007	summer	7.6	0.03	0.34	0.003	92.0	59.6
Boone	05009	summer	7.6	0.03	0.34	0.003	92.0	59.6
Bradley	05011	summer	7.6	0.03	0.34	0.003	93.0	65.2
Calhoun	05013	summer	7.6	0.03	0.34	0.003	93.0	65.2
Carroll	05015	summer	7.6	0.03	0.34	0.003	92.0	59.6
Chicot	05017	summer	7.6	0.03	0.34	0.003	92.8	68.8
Clark	05019	summer	7.6	0.03	0.34	0.003	93.0	65.2
Clay	05021	summer	7.6	0.03	0.34	0.003	89.8	69.0
Cleburne	05023	summer	7.6	0.03	0.34	0.003	89.3	65.4
Cleveland	05025	summer	7.6	0.03	0.34	0.003	93.0	65.2
Columbia	05027	summer	7.6	0.03	0.34	0.003	93.0	65.2
Conway	05029	summer	7.6	0.03	0.34	0.003	92.8	73.3
Craighead	05031	summer	7.6	0.03	0.34	0.003	89.8	69.0
Crawford	05033	summer	7.6	0.03	0.34	0.003	92.5	65.1
Crittenden	05035	summer	7.6	0.03	0.34	0.003	92.9	67.9
Cross	05037	summer	7.6	0.03	0.34	0.003	92.9	67.9
Dallas	05039	summer	7.6	0.03	0.34	0.003	93.0	65.2
Desha	05041	summer	7.6	0.03	0.34	0.003	92.8	68.8
Drew	05043	summer	7.6	0.03	0.34	0.003	92.8	68.8
Faulkner	05045	summer	7.6	0.03	0.34	0.003	92.8	73.3
Franklin	05047	summer	7.6	0.03	0.34	0.003	92.5	65.1
Fulton	05049	summer	7.6	0.03	0.34	0.003	89.3	65.4
Garland	05051	summer	7.6	0.03	0.34	0.003	92.8	73.3
Grant	05053	summer	7.6	0.03	0.34	0.003	92.8	73.3
Greene	05055	summer	7.6	0.03	0.34	0.003	89.8	69.0
Hempstead	05057	summer	7.6	0.03	0.34	0.003	92.2	67.6
Hot Spring	05059	summer	7.6	0.03	0.34	0.003	92.8	73.3

AR State Counties	FIPS Code	Season	RVP (psi)	Gasoline Sulfur (%)	Diesel Sulfur (%)	CNG/LPG Sulfur (%)	Max. Temp. (F)	Min. Temp. (F)
Howard	05061	summer	7.6	0.03	0.34	0.003	92.2	67.6
Independence	05063	summer	7.6	0.03	0.34	0.003	89.8	69.0
Izard	05065	summer	7.6	0.03	0.34	0.003	89.3	65.4
Jackson	05067	summer	7.6	0.03	0.34	0.003	89.8	69.0
Jefferson	05069	summer	7.6	0.03	0.34	0.003	92.8	68.8
Johnson	05071	summer	7.6	0.03	0.34	0.003	92.5	65.1
Lafayette	05073	summer	7.6	0.03	0.34	0.003	92.2	67.6
Lawrence	05075	summer	7.6	0.03	0.34	0.003	89.8	69.0
Lee	05077	summer	7.6	0.03	0.34	0.003	92.9	67.9
Lincoln	05079	summer	7.6	0.03	0.34	0.003	92.8	68.8
Little River	05081	summer	7.6	0.03	0.34	0.003	92.2	67.6
Logan	05083	summer	7.6	0.03	0.34	0.003	92.5	65.1
Lonoke	05085	summer	7.6	0.03	0.34	0.003	92.9	67.9
Madison	05087	summer	7.6	0.03	0.34	0.003	92.0	59.6
Marion	05089	summer	7.6	0.03	0.34	0.003	89.3	65.4
Miller	05091	summer	7.6	0.03	0.34	0.003	92.2	67.6
Mississippi	05093	summer	7.6	0.03	0.34	0.003	89.8	69.0
Monroe	05095	summer	7.6	0.03	0.34	0.003	92.9	67.9
Montgomery	05097	summer	7.6	0.03	0.34	0.003	92.2	67.6
Nevada	05099	summer	7.6	0.03	0.34	0.003	93.0	65.2
Newton	05101	summer	7.6	0.03	0.34	0.003	92.0	59.6
Ouachita	05103	summer	7.6	0.03	0.34	0.003	93.0	65.2
Perry	05105	summer	7.6	0.03	0.34	0.003	92.8	73.3
Phillips	05107	summer	7.6	0.03	0.34	0.003	92.9	67.9
Pike	05109	summer	7.6	0.03	0.34	0.003	92.2	67.6
Poinsett	05111	summer	7.6	0.03	0.34	0.003	89.8	69.0
Polk	05113	summer	7.6	0.03	0.34	0.003	92.5	65.1
Pope	05115	summer	7.6	0.03	0.34	0.003	92.8	73.3
Prairie	05117	summer	7.6	0.03	0.34	0.003	92.9	67.9
Pulaski	05119	summer	7.6	0.03	0.34	0.003	92.8	73.3
Randolph	05121	summer	7.6	0.03	0.34	0.003	89.8	69.0
Saline	05125	summer	7.6	0.03	0.34	0.003	92.8	73.3
Scott	05127	summer	7.6	0.03	0.34	0.003	92.5	65.1
Searcy	05129	summer	7.6	0.03	0.34	0.003	89.3	65.4
Sebastian	05131	summer	7.6	0.03	0.34	0.003	92.5	65.1
Sevier	05133	summer	7.6	0.03	0.34	0.003	92.2	67.6
Sharp	05135	summer	7.6	0.03	0.34	0.003	89.3	65.4
St. Francis	05123	summer	7.6	0.03	0.34	0.003	92.9	67.9
Stone	05137	summer	7.6	0.03	0.34	0.003	89.3	65.4
Union	05139	summer	7.6	0.03	0.34	0.003	93.0	65.2
Van Buren	05141	summer	7.6	0.03	0.34	0.003	89.3	65.4
Washington	05143	summer	7.6	0.03	0.34	0.003	92.0	59.6
White	05145	summer	7.6	0.03	0.34	0.003	89.8	69.0
Woodruff	05147	summer	7.6	0.03	0.34	0.003	92.9	67.9
Yell	05149	summer	7.6	0.03	0.34	0.003	92.8	73.3

AR State Counties	FIPS Code	Season	RVP (psi)	Gasoline Sulfur (%)	Diesel Sulfur (%)	CNG/LPG Sulfur (%)	Max. Temp. (F)	Min. Temp. (F)
Arkansas	05001	winter	12.7	0.03	0.34	0.003	54.1	32.7
Ashley	05003	winter	12.7	0.03	0.34	0.003	56.4	35.6
Baxter	05005	winter	12.7	0.03	0.34	0.003	48.6	31.3
Benton	05007	winter	12.7	0.03	0.34	0.003	56.4	20.7
Boone	05009	winter	12.7	0.03	0.34	0.003	56.4	20.7
Bradley	05011	winter	12.7	0.03	0.34	0.003	59.3	29.7
Calhoun	05013	winter	12.7	0.03	0.34	0.003	59.3	29.7
Carroll	05015	winter	12.7	0.03	0.34	0.003	56.4	20.7
Chicot	05017	winter	12.7	0.03	0.34	0.003	56.4	35.6
Clark	05019	winter	12.7	0.03	0.34	0.003	59.3	29.7
Clay	05021	winter	12.7	0.03	0.34	0.003	48.5	34.4
Cleburne	05023	winter	12.7	0.03	0.34	0.003	48.6	31.3
Cleveland	05025	winter	12.7	0.03	0.34	0.003	59.3	29.7
Columbia	05027	winter	12.7	0.03	0.34	0.003	59.3	29.7
Conway	05029	winter	12.7	0.03	0.34	0.003	54.5	36.6
Craighead	05031	winter	12.7	0.03	0.34	0.003	48.5	34.4
Crawford	05033	winter	12.7	0.03	0.34	0.003	53.2	29.8
Crittenden	05035	winter	12.7	0.03	0.34	0.003	54.1	32.7
Cross	05037	winter	12.7	0.03	0.34	0.003	54.1	32.7
Dallas	05039	winter	12.7	0.03	0.34	0.003	59.3	29.7
Desha	05041	winter	12.7	0.03	0.34	0.003	56.4	35.6
Drew	05043	winter	12.7	0.03	0.34	0.003	56.4	35.6
Faulkner	05045	winter	12.7	0.03	0.34	0.003	54.5	36.6
Franklin	05047	winter	12.7	0.03	0.34	0.003	53.2	29.8
Fulton	05049	winter	12.7	0.03	0.34	0.003	48.6	31.3
Garland	05051	winter	12.7	0.03	0.34	0.003	54.5	36.6
Grant	05053	winter	12.7	0.03	0.34	0.003	54.5	36.6
Greene	05055	winter	12.7	0.03	0.34	0.003	48.5	34.4
Hempstead	05057	winter	12.7	0.03	0.34	0.003	56.5	32.1
Hot Spring	05059	winter	12.7	0.03	0.34	0.003	54.5	36.6
Howard	05061	winter	12.7	0.03	0.34	0.003	56.5	32.1
Independence	05063	winter	12.7	0.03	0.34	0.003	48.5	34.4
Izard	05065	winter	12.7	0.03	0.34	0.003	48.6	31.3
Jackson	05067	winter	12.7	0.03	0.34	0.003	48.5	34.4
Jefferson	05069	winter	12.7	0.03	0.34	0.003	56.4	35.6
Johnson	05071	winter	12.7	0.03	0.34	0.003	53.2	29.8
Lafayette	05073	winter	12.7	0.03	0.34	0.003	56.5	32.1
Lawrence	05075	winter	12.7	0.03	0.34	0.003	48.5	34.4
Lee	05077	winter	12.7	0.03	0.34	0.003	54.1	32.7
Lincoln	05079	winter	12.7	0.03	0.34	0.003	56.4	35.6
Little River	05081	winter	12.7	0.03	0.34	0.003	56.5	32.1
Logan	05083	winter	12.7	0.03	0.34	0.003	53.2	29.8
Lonoke	05085	winter	12.7	0.03	0.34	0.003	54.1	32.7
Madison	05087	winter	12.7	0.03	0.34	0.003	56.4	20.7
Marion	05089	winter	12.7	0.03	0.34	0.003	48.6	31.3

AR State Counties	FIPS Code	Season	RVP (psi)	Gasoline Sulfur (%)	Diesel Sulfur (%)	CNG/LPG Sulfur (%)	Max. Temp. (F)	Min. Temp. (F)
Miller	05091	winter	12.7	0.03	0.34	0.003	56.5	32.1
Mississippi	05093	winter	12.7	0.03	0.34	0.003	48.5	34.4
Monroe	05095	winter	12.7	0.03	0.34	0.003	54.1	32.7
Montgomery	05097	winter	12.7	0.03	0.34	0.003	56.5	32.1
Nevada	05099	winter	12.7	0.03	0.34	0.003	59.3	29.7
Newton	05101	winter	12.7	0.03	0.34	0.003	56.4	20.7
Ouachita	05103	winter	12.7	0.03	0.34	0.003	59.3	29.7
Perry	05105	winter	12.7	0.03	0.34	0.003	54.5	36.6
Phillips	05107	winter	12.7	0.03	0.34	0.003	54.1	32.7
Pike	05109	winter	12.7	0.03	0.34	0.003	56.5	32.1
Poinsett	05111	winter	12.7	0.03	0.34	0.003	48.5	34.4
Polk	05113	winter	12.7	0.03	0.34	0.003	53.2	29.8
Pope	05115	winter	12.7	0.03	0.34	0.003	54.5	36.6
Prairie	05117	winter	12.7	0.03	0.34	0.003	54.1	32.7
Pulaski	05119	winter	12.7	0.03	0.34	0.003	54.5	36.6
Randolph	05121	winter	12.7	0.03	0.34	0.003	48.5	34.4
Saline	05125	winter	12.7	0.03	0.34	0.003	54.5	36.6
Scott	05127	winter	12.7	0.03	0.34	0.003	53.2	29.8
Searcy	05129	winter	12.7	0.03	0.34	0.003	48.6	31.3
Sebastian	05131	winter	12.7	0.03	0.34	0.003	53.2	29.8
Sevier	05133	winter	12.7	0.03	0.34	0.003	56.5	32.1
Sharp	05135	winter	12.7	0.03	0.34	0.003	48.6	31.3
St. Francis	05123	winter	12.7	0.03	0.34	0.003	54.1	32.7
Stone	05137	winter	12.7	0.03	0.34	0.003	48.6	31.3
Union	05139	winter	12.7	0.03	0.34	0.003	59.3	29.7
Van Buren	05141	winter	12.7	0.03	0.34	0.003	48.6	31.3
Washington	05143	winter	12.7	0.03	0.34	0.003	56.4	20.7
White	05145	winter	12.7	0.03	0.34	0.003	48.5	34.4
Woodruff	05147	winter	12.7	0.03	0.34	0.003	54.1	32.7
Yell	05149	winter	12.7	0.03	0.34	0.003	54.5	36.6

Table A-3. Assignment of urban, suburban, and rural vehicle registration distribution.

	Co. Name	
1	Arkansas	R
2	Ashley	R
3	Baxter	R
4	Boone	R
5	Bradley	R
6	Calhoun	R
7	Carroll	R
8	Chicot	R
9	Clark	R
10	Clay	R
11	Cleburne	R
12	Columbia	R
13	Conway	R
14	Cross	R
15	Dallas	R
16	Desha	R
17	Drew	R
18	Fulton	R
19	Greene	R
20	Hempstead	R
21	Hot Spring	R
22	Howard	R
23	Independence	R
24	Izard	R
25	Jackson	R
26	Johnson	R
27	Lafayette	R
28	Lawrence	R
29	Lee	R
30	Little River	R
31	Logan	R
32	Marion	R
33	Mississippi	R
34	Monroe	R
35	Montgomery	R
36	Nevada	R
37	Newton	R
38	Ouachita	R

	Co. Name	
39	Phillips	R
40	Pike	R
41	Polk	R
42	Pope	R
43	Prairie	R
44	Randolph	R
45	Scott	R
46	Searcy	R
47	Sevier	R
48	Sharp	R
49	St. Francis	R
50	Stone	R
51	Union	R
52	Van Buren	R
53	White	R
54	Woodruff	R
55	Yell	R
56	Benton	S+U
57	Cleveland	S+R
58	Craighead	S
59	Crawford	S+U
60	Crittenden	S
61	Faulkner	S
62	Franklin	S+R
63	Garland	S
64	Grant	S+R
65	Jefferson	S
66	Lincoln	S+R
67	Lonoke	S
68	Madison	S+R
69	Miller	S
70	Perry	S+R
71	Poinsett	S+R
72	Saline	S
73	Sebastian	S+U
74	Washington	S+U
75	Pulaski	U

R = rural	Use Lonoke County distributions
S = suburban	Use the average of Saline and Faulkner Counties
U = urban	Use Pulaski County
S+U	Use .5*Pulaksi + .5(Saline + Faulkner)
S+R	Use .5*Lonoke + .5(Saline + Faulkner)

APPENDIX C

MACTEC

DATE:	March 24, 2005
TO:	Mr. Mike Bonds Arkansas Department of Environmental Quality 8001 National Drive P.O. Box 8913 Little Rock, AR 72219-8913
FROM:	Ms. Lori Williams, MACTEC MACTEC Project 827004X068.001
CONTRACT:	Contract No. 4600007240 *Restructure and Improve Arkansas 2002 i-STEPS Database*
SUBJECT:	Final Report for Task 3

Under Contract No. 4600007240, MACTEC began restructuring/improvement efforts on the Arkansas 2002 *i*-STEPS database. The Arkansas Department of Environmental Quality (ADEQ) uses the MACTEC software *i*-STEPS to store emission inventory data and transport this information to USEPA for the National Environmental Network. ADEQ contracted MACTEC to review the 2002 *i*-STEPS point source emissions submitted to USEPA in 2004 and correct errors in the database prior to resubmitting the data to USEPA by May 1, 2005. The restructuring/improvement effort consists of four tasks:

1. Restructure *i*-STEPS Database
2. Improvement of 2002 *i*-STEPS Emissions (Crittenden County Only)
3. Improvement of 2002 *i*-STEPS Emissions (Statewide)
4. Develop Customized *i*-STEPS Users' Manual

MACTEC completed Task 1 and 2 in December 2004. Task 3 was approved by the Arkansas Legislature in December 2004; work began on site at ADEQ in January 2005 and scheduled to be completed by March 25, 2005. Task 4 will be completed in April, 2005 from MACTEC's RTP office.

The current effort to restructure and improve the *i*-STEPS databases are a direct result of the initiative by Mr. Mike Hile and Mr. Ron Hoofman of the ADEQ Planning Branch. With cooperation from Ms. Evelyn Withers and the Data Management staff, MACTEC has been able to complete Task 3 by the anticipated March 25 deadline. MACTEC provided one to two full-time employees that have worked on site at ADEQ during Task 3's duration. This memorandum outlines the methodology used by MACTEC to complete Task 3, the improvements that have resulted from the effort, and recommendations for continued improvements of the data quality in current and upcoming ADEQ emission inventories.

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Methodology

For Task 3, ADEQ directed MACTEC to focus their on-site efforts on two major goals. The primary goal was to quality assure (QA) and make corrections when needed to the 2002 *i*-STEPS database. The second goal was to work with the Data Management staff and provide direction/assistance on data entry into the 2003 *i*-STEPS database.

During the QA process, MACTEC focused on the following items:

- confirming that no Groups or Processes were deleted by Task 1 (Restructure *i*-STEPS Database),
- confirming the inventory year (confirm emissions were for 2002),
- reviewing Source Classification Code (SCC) selections for each Process record (modify per Permitting/engineer mark ups),
- using default SCC units (use standard SCC units only),
- reviewing Process Rates entered (only enter if throughputs provided by the facility were in the standard SCC units),
- reviewing Process Unit Emissions records (confirm that 2002 emissions entered matched emissions provided by the facility), and
- documenting changes made to the 2002 *i*-STEPS database for each facility (this information will be passed on to Data Management for application to the 2003 *i*-STEPS database).

MACTEC was instructed by ADEQ that QA of the Type A facilities was top priority. 74 "major" or Type A facilities provided 2002 emission inventories. There were a total of 246 emission inventories submitted in 2002, so 172 were provided by "minor" or Type B facilities in Arkansas.

Project Status

During the three months on site at ADEQ, MACTEC completed the following items:

- Completed the QA of 74 Type A facilities and 172 Type B facilities and provided SCC markups and other notes to be used by Data Management for application to the 2003 and subsequent inventories.
- MACTEC resolved the orphan record issue that occurred from Task 1 actions.
- Removed all Control Scenario records from the 2002 and 2003 databases, with Data Management's approval and assistance from Mr. Jerry Baker, so that old AFS control efficiencies would not be applied to emissions entered by staff.
- Met with Planning Branch to discuss compliance (specifically Air Program) connectivity in the *i*-STEPS database and other concerns regarding this type of data. Issues regarding the Air Program data were resolved by MACTEC.

- Worked with Mr. Jerry Baker to get the latest version of *i*-STEPS installed (updated in January and March 2005).
- Worked individually with Data Management staff on loading emission inventory data into the restructured *i*-STEPS database.
- Provided assistance to Data Management staff on standard SCC units, throughput conversions, and table edits.
- Provided a comparison of the emissions from the 2002 emission inventory (as of January 1, 2005) versus the 2002 emission inventory after MACTEC's QA.
- Attended the Planning Branch monthly meetings and presented updates of the project.

Recommendations

Based on what was learned during the QA effort, MACTEC submits the following recommendations for continued maintenance and improvement of the ADEQ point source emission inventory:

- The Source Number from the permit should be included as part of the Group and Process Descriptions for clarity.
- The Planning Branch should implement a QA process to evaluate emission inventories received from the facilities for completeness prior to the package being sent to Data Management for data entry. Therefore, missing data elements could be requested from the facility and clarified prior to the data entry process.
- The SCCs selected by MACTEC and/or ADEQ should be reviewed by the facilities to ensure that the selection accurately represent the permitted emission source. This review would reduce potential risks to the facility generated from the association of mistaken source classifications by an outsider. Without the facilities input, ADEQ has no other option than to make an assessment of the permitted emission source and assign a SCC based on this limited knowledge.
- ADEQ should develop a policy against facilities reporting the permit limits for each source instead of actual estimated emissions. MACTEC noted that roughly 10 percent of the facilities in the ADEQ emission inventory submittals reported permit limits as their actual 2002 emissions. When facilities choose to report emissions at the permit limit instead of actual emissions, the quality of the ADEQ emission inventory is negatively impacted. The most likely scenario resulting from this practice is that the ADEQ emission inventory is inflated, but alternatively some facilities may actually be operating beyond permitted limits.
- ADEQ should develop an emission inventory and/or permitting policy regarding the "lumping" of emission sources for reporting purposes. MACTEC recommends that facilities be required to follow the permit when reporting emissions and not combine individually permitted units. It is impossible to hold facilities responsible for permitted emission limits unless the emissions are reported for each permitted source.
- The Permits Branch should work with The Planning Branch to maintain permit and inventory data in one system. Based on recent information compiled by MACTEC

regarding the National Emission Inventory (NEI) revisions, several states have requested that USEPA obtain permit limits with emission inventory data. This would allow states to have accountability. ADEQ currently maintains this information in *i*-STEPS. Therefore, if USEPA does request this type of information in future versions of the NEI Input Format (NIF) ADEQ will be ahead of other states. The Permits Branch does not consider this to be a function of ADEQ's *i*-STEPS database and is currently not involved with QA of this data.

- ADEQ may want to consider using the Satellite version of *i*-STEPS. MACTEC is currently preparing a web Satellite *i*-STEPS that is compliant with the USEPA's proposed Cross-Media Electronic Reporting and Recordkeeping Rule (CROMERRR). MACTEC is working for and in collaboration with five state agencies (Delaware Department of Natural Resources and Environment Control, Kansas Department of Health and Environment, South Carolina Department of Health and Environmental Control, Indiana Department of Environmental Management, and Arizona Department of Environmental Quality) on this effort. This initiative will be completed in April 2005.

  The Web Satellite initiative will provide users with a browser-based interface to i-STEPS using traditional web-tools. The application would allow industries to furnish their data directly to ADEQ.

- ADEQ may want to consider using MACTEC's Document Archive and Retrieval Technology (DART). DART allows organizations to easily convert large amounts of paper and other hardcopy documents into an organized electronic filing cabinet. The system provides the user with sophisticated information retrieval capabilities that are intuitive and easy to use.

  ADEQ might want to consider using DART in a manner similar to another i-STEPS user, the Philadelphia Air Management Services. MACTEC scanned Philadelphia's permits, project files, and reports and then linked the electronic files to i-STEPS. This DART application allows Philadelphia to pull up the permit for a facility within i-STEPS. ADEQ may also want to consider linking emission inventories submitted by the facility for tracking purposes.

We wish to extend our thanks to your staff for assisting us in conducting a thorough review of your 2002 *i*-STEPS point source emission inventory. If you have any question, please contact me at (919) 941-0333 Ext. 277.

MACTEC Comparison of Task 3
2002 ADEQ Emission Inventory

2002 Emission Totals Prior to Task 3

County	Pollutant (TPY)							
	CO	NO2	PM10	PM2.5	PT	SO2	VOC	Pb
Arkansas	56	41	568	0	544	66	1235	0
Ashley	20905	4200	1878	7	2557	3324	2836	25
Baxter	0.2	1	1	0	0.4	0.06	47	0
Benton	596	5176	186	0	395	10985	242	0.07
Boone	31	2	58	12	0	1	39	0
Bradley	323	134	58	2	0.01	23	85	0.03
Calhoun	164	177	293	26	101	10	233	0.09
Carroll	0	0	0	0	0	0	0	0
Chicot	0	0	0	0	0	0	0	0
Clark	335	16529	131	43	188	20	837	8
Clay	0	0	19	0	19	0	73980	12
Cleburne	0	0	0	0	0	0	85	0
Cleveland	0	0	0	0	0	0	0	0
Columbia	645	547	444	74	327	1129	1310	0.3
Conway	1315	541	881	0	1368	486	1630	0.1
Craighead	62	364	134	7	35	116	232	0
Crawford	18	20	3	0	1	0.09	329	0
Crittenden	132	273	103	0	103	172	663	0.003
Cross	593	24	13	0	2	10	12	0
Dallas	640	151	270	80	207	7	259	0.02
Desha	559	1191	195	0	9	27	871	18
Drew	0	0	0.5	0	0	0	433	0
Faulkner	0.6	3	4	0	0.2	3	293	0
Franklin	950	1324	69	41	22	205	369	0
Fulton	0	0	0	0	0	0	0	0
Garland	469	188	517	198	80	10	293	0
Grant	373	123	160	3130	341	16	662	0.4
Greene	43	47	135	0	5	3	9186	18
Hempstead	154	107	109	12	89	9	530	0.00004
Hot Springs	774	1961	262	14	210	218	976	0.02
Howard	606	460	103	0	196	12	1270	0
Independence	5157	312	1364	1340	22765	32505	912	1
Izard	17	4	78	0	0	1	28	0
Jackson	261	120	85	0	116	22	16	1
Jefferson	9200	19142	2051	1140	795	34529	25756	1
Johnson	333	331	46	34	3	55	103	0
Lafayette	97	262	2	0	2	608	9	0
Lawarence	0	0	0	0	0	0	0	0
Lee	17	61	3	3	0	10	4	0
Lincoln	123	125	0	0	0	0.06	0.4	0
Little River	4059	3613	679	0	500	2213	1031	0.8
Logan	138	2067	6	0	9	0.4	18	0
Lonoke	634	704	0	0	0	0.05	6	0
Madison	0	0	0	0	0	0	0	0
Marion	0	0	29	0	29	0	178	0
Miller	550	2369	18	2	13	2	231	0
Mississippi	3017	3214	522	34	317	828	976	0.3
Monroe	0	0	0	0	0	0	0	0
Montgomery	0	0	0	0	0	0	0	0
Nevada	524	77	61	0	1526	26	398	0
Newton	0	0	0	0	0	0	0	0
Ouachita	147	424	153	153	302	193	206	0.002
Perry	0	0	0	0	0	0	0	0
Phillips	137	348	12	2	0	1	167	0.2
Pike	88	136	39	2	54	6	164	0.03
Poinsett	0	0	0	0	0	0	0	0
Polk	0	0	0	0	0	0	0	0
Pope	165	126	120	2	801	1	517	0
Prairie	0	0	0	0	0	0	0	0
Pulaski	248	470	440	57	72	25	557	54

MACTEC Comparison of Task 3
2002 ADEQ Emission Inventory

2002 Emission Totals Prior to Task 3

	Pollutant (TPY)							
County	CO	NO2	PM10	PM2.5	PT	SO2	VOC	Pb
Randolph	133	611	14	7	7	0.2	119	0
Saint Francis	26	51	1	0	0	0.3	2	0
Saline	57	409	3846	0	3562	2659	48	0
Scott	21	21	31	23	61	2	83	0.09
Searcy	0	0	0	0	0	0	0	0
Sebastian	1033	507	375	5	144	269	580	0.02
Sevier	0	0	0	0	0	0	0	0
Sharp	0	0	0	0	0	0	0	0
Stone	0	0	0	0	0	0	0	0
Union	1824	2685	1267	0	1116	821	9078	30
Van Buren	0	0	0	0	0	0	0	0
Washington	79	92	117	0	0	1	91	0.0001
White	388	1066	48	10	33	1	624	0
Woodruff	0	0	0	0	0	0	0	0
Yell	110	57	31	0	49	5	134	0.2
Portable Sources	72	72	11	27	0	11	25	3
Totals	**58399**	**73060**	**18044**	**6487**	**39076**	**91647**	**140998**	**174**

MACTEC Comparison of Task 3
2002 ADEQ Emission Inventory

2002 Emission Totals After Task 3

	Pollutant (TPY)							
County	CO	NO2	PM10	PM2.5	PT	SO2	VOC	Pb
Arkansas	59	481	159	0	135	66	616	0
Ashley	21519	3381	703	9	43	3210	2611	16
Baxter	0.2	1	1	0	0.4	0.06	44	0
Benton	597	5170	184	0	0	10966	390	0.06
Boone	31	2	46	12	0	1	39	0
Bradley	323	134	49	2	0	23	321	0.03
Calhoun	150	10	238	28	314	10	136	0.08
Carroll	0	0	0	0	0	0	0	0
Chicot	0	0	0	0	0	0	0	0
Clark	335	383	130	43	0	20	326	8
Clay	0	0	1	0	7	0	52774	0
Cleburne	0	0	0	0	0	0	18	0
Cleveland	0	0	0	0	0	0	0	0
Columbia	526	337	401	74	96	1122	908	0.3
Conway	1315	541	881	0	1372	486	1494	0.1
Craighead	61	361	134	7	33	114	197	0
Crawford	8	11	1	0	1	0.06	329	0
Crittenden	92	273	103	0	0	172	578	0.003
Cross	275	13	5	0	0	0.3	71	0
Dallas	671	151	334	80	269	7	259	0.02
Desha	537	889	187	0	0	27	830	0
Drew	0.03	0.0008	0.5	0	0	0.002	433	0.000002
Faulkner	0.6	3	5	0	0.2	3	291	0
Franklin	862	746	74	60	137	319	221	0.001
Fulton	0	0	0	0	0	0	0	0
Garland	457	142	492	198	80	9	236	0
Grant	193	87	117	40	19	14	510	0.4
Greene	26	140	8	0	0.09	3	552	4
Hempstead	155	111	109	11	98	9	531	0.00005
Hot Springs	587	1089	164	14	34	217	868	0
Howard	604	457	112	0	77	12	1169	0
Independence	3463	16498	1012	8	0	30983	938	1
Izard	86	4	78	0	0	1	28	0
Jackson	265	107	84	0	81	22	863	1
Jefferson	8739	19064	1776	1141	27	34500	4993	2
Johnson	334	333	48	36	0	55	103	0
Lafayette	97	262	2	0	0	608	9	0
Lawarence	0	0	0	0	0	0	0	0
Lee	29	198	3	3	0	24	4	0
Lincoln	123	101	0	0	0	0	0.4	0
Little River	4059	3727	679	0	0	2213	1034	0.8
Logan	152	2119	27	0	0	7	19	0
Lonoke	228	201	0	0	0	0.002	0.6	0
Madison	0	0	0	0	0	0	0	0
Marion	0	0	17	0	17	0	159	0
Miller	80	218	12	2	7	0.6	156	0
Mississippi	3745	2819	288	33	151	724	967	0.3
Monroe	0	0	0	0	0	0	0	0
Montgomery	0	0	0	0	0	0	0	0
Nevada	524	78	55	0	29	26	398	0
Newton	0	0	0	0	0	0	0	0
Ouachita	159	282	153	153	0	443	206	0.002
Perry	0	0	0	0	0	0	0	0
Phillips	136	331	12	2	0	1	160	0.2
Pike	88	136	39	2	52	6	164	0.03
Poinsett	0	0	0	0	0	0	0	0
Polk	0	0	0	0	0	0	0	0
Pope	164	110	130	29	80	0.4	466	0
Prairie	0	0	0	0	0	0	0	0
Pulaski	193	389	380	9	0.1	21	429	0.002

MACTEC Comparison of Task 3
2002 ADEQ Emission Inventory

2002 Emission Totals After Task 3

	Pollutant (TPY)							
County	CO	NO2	PM10	PM2.5	PT	SO2	VOC	Pb
Randolph	120	598	8	7	6	0.2	306	0
Saint Francis	26	51	0.7	0	0	0.3	2	0
Saline	71	305	577	32	566	54	66	0
Scott	21	21	33	23	32	2	165	0.09
Searcy	0	0	0	0	0	0	0	0
Sebastian	660	242	275	4	6	145	498	3
Sevier	127	3	0.2	0	0	0.2	20	0
Sharp	0	0	0	0	0	0	0	0
Stone	0	0	0	0	0	0	0	0
Union	1986	2715	1410	52	1945	2545	6309	29
Van Buren	0	0	0	0	0	0	0	0
Washington	73	74	99	0	0	1	1475	0.0001
White	383	1065	40	10	10	1	642	0
Woodruff	1	153	44	44	0	380	4	0.01
Yell	133	0	3	0	6	5	134	0.1
Portable Sources	72	72	11	27	0	11	25	3
Totals	**55721**	**67189**	**11934**	**2195**	**5731**	**89590**	**87495**	**70**

MACTEC Comparison of Task 3
2002 ADEQ Emission Inventory

Statewide Summary

	Pollutant (TPY)							
Statewide	**CO**	**NO2**	**PM10**	**PM2.5**	**PT**	**SO2**	**VOC**	**Pb**
Before	58399	73060	18044	6487	39076	91647	140998	174
After	55721	67189	11934	2195	5731	89590	87495	70
Before - After =	2678	5871	6109	4292	33345	2057	53503	104
Percent Change	**5%**	**8%**	**34%**	**66%**	**85%**	**2%**	**38%**	**60%**

APPENDIX D

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

NOV 18 2002

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

SUBJECT: 2002 Base Year Emission Inventory SIP Planning: 8-hr Ozone, $PM_{2.5}$ and Regional Haze Programs

FROM: for John O Edwards
Lydia N. Wegman, Director
Air Quality Strategies and Standards Division

Peter Tsirigotis, Director P Tsirigotis
Emissions, Monitoring, and Analysis Division

TO: Regional Air Division Directors

The EPA anticipates that nonattainment designations for the 8-hour ozone national ambient air quality standards (NAAQS) will occur in 2004, and the designations for the fine particles ($PM_{2.5}$) NAAQS will occur in the 2004-2005 time frame. Within 3-4 years after designations are promulgated, States will need to submit new attainment demonstration State implementation plans (SIPs) for the new NAAQS. A key element in the overall SIP planning process is the need for updated statewide emission inventories. This memorandum identifies 2002 as the anticipated emission inventory (EI) base year for the SIP planning process to address these pollutants. Identifying the base year at this time gives certainty to States, and the selection of 2002 harmonizes dates for other reporting requirements, e.g., EPA's Consolidated Emissions Reporting Rule (CERR) that requires submission of EI every three years; 2002 is one of the required years for such updates.

The Agency encourages States to take early action to reduce emissions of pollutants that cause violations of the NAAQS for ozone (the 8-hour standard) and $PM_{2.5}$, and that cause regional haze. States will be able to take credit for emission reductions that occur after the 2002 base year, including reductions that occur before the deadlines for submission of these SIPs. As a matter of policy, EPA seeks to avoid penalizing States for moving forward early to address these problems. Attached is additional information.

The EPA is aware that some areas have already begun on a voluntary basis to model for purposes of the 8-hour ozone standard. These areas may continue to use modeling from previous base years for each set of meteorological episode conditions for use in their SIP submittals if these studies are still applicable for an attainment demonstration. The 2002 EI, however, needs to be factored into this analysis. For example, the 2002 inventory would be a good choice for use in modeling "current" emissions. As described in the modeling guidance, predictions for the current emissions and predictions for the future year emissions are used in the modeled attainment test[1]. Furthermore, for reasonable further progress (RFP) purposes, the 2002 EI needs to be used as the base year.

Please make this guidance available to the appropriate contacts in your State and local air agencies. Questions on this should be directed to (for ozone) Annie Nikbakht at 919-54l-5246 or (for $PM_{2.5}$) Rich Damberg at 919-54l-5592.

cc: Lydia Wegman
Peter Tsirigotis
Rich Ossias
Kevin McLean

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[1]U.S. EPA, (1999), "*Guidance onthe use of models and other analyses in attainment demonstrations for the 8-hour ozone NAAQS,*" DRAFT, May 1999, Web site: http://www.epa.gov/tnn/scram, under Guidance/Support, file name: O3TEST.

Attachment

Background

The EPA anticipates that designations for the 8-hour ozone NAAQS will occur in 2004, and the designations for the $PM_{2.5}$ NAAQS will occur in the 2004-2005 time frame. The Clean Air Act (CAA) requires States to submit attainment demonstration SIPs for the 8-hour ozone standard within 3 to 4 years (depending on classification), and within 3 years for the $PM_{2.5}$ standard. Therefore, EPA anticipates that SIPs will be due in 2007 or 2008[2] for both NAAQS programs. For regional haze, most States (i.e., those participating in regional planning organizations) will have SIPs due at the same time as $PM_{2.5}$ SIPs. We anticipate that technical analyses in support of these SIPs, such as regional scale air quality modeling, will need to begin no later than the 2004 time frame. Updated statewide emissions inventories will be an important component used in these analyses. In addition, for many of the required SIPs, emissions in upwind States will also be an important input to necessary technical analyses.

For the 8-hour ozone, $PM_{2.5}$, and regional haze program areas, there are statutory and regulatory provisions related to prospective and/or retrospective demonstrations of progress in reducing emissions and/or improving air quality, although the exact provisions differ somewhat across programs. We have considered the statutory and regulatory provisions applicable to each of these program areas, and have concluded that in each case 2002 is an appropriate base year for program requirements related to progress. In addition, there are practical reasons for choosing 2002, as explained below.

Therefore, even though EPA has not developed final rules or guidance for implementation of either the 8-hour ozone NAAQS or the $PM_{2.5}$ NAAQS, EPA believes that 2002 should be the base year inventory for these SIP planning efforts, including for regional haze SIPs. Using the 2002 inventory as the base year will also ensure that the inventory reflects one of the years used for calculating the air quality design values on which designation decisions are based, as well as one of the years in the 2000-2004 period used to establish baseline visibility levels for the regional haze program. Our reasoning is explained in more detail below for each program area.

The year 2002 is also suitable as the principle or one of the principle years used for air quality model validation.

The practical reasons for choosing 2002 have to do with the requirements of the CERR (67 Federal Register 39602), which was finalized on June 10, 2002, and with the schedule of EPA's own work on the National Emissions Inventory. The CERR requires States to submit

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[2]The EPA is still working on the implementation guidance that will address the extent to which subparts 1 and 2 of the CAA apply for purposes of the 8-hour ozone NAAQS. Subpart 1 provides up to three years after nonattainment designation for States to submit attainment and reasonable further progress (RFP) SIPs, while subpart 2 provides 3 to 4 years, depending on an area's classification, for States to submit those plans.

emissions inventories for all criteria pollutants and their precursors every three years, on a schedule that includes the emissions year 2002. The due date for the 2002 emission inventory is established in the CERR as June 2004. Therefore, each State should have information available some time before this date to develop the in-state emissions inventory needed for technical analyses during 2004. In addition, EPA plans to make its initial version of the 2002 National Emission Inventory (NEI) available to the states by December 2003, based on 2002 data on emissions from electric generating units, preliminary 2002 vehicle miles traveled information from the Federal Highway Administration, and growth and control projections starting with the 1999 NEI for other source types. This preliminary 2002 NEI can be used in 2004 by each State needing emission estimates for upwind States. The EPA's final 2002 NEI, which will merge and augment the state-by-state inventories received in 2004, will be ready by the summer of 2005. Depending on where they are in their work, States may wish to switch to the newer estimates of upwind-states' emissions, and certainly should at least consider how the emission estimates for upwind States have changed.

Alternatively, some regional groupings of States may exchange and merge their 2002 inventories directly, prior to completion of EPA's final 2002 NEI. We will be consulting with multi-state organizations about the 2002 inventory process so that work is not duplicated unnecessarily.

8-hour Ozone NAAQS

Under the 8-hour ozone standard, EPA anticipates that many areas designated nonattainment for the 8-hour ozone NAAQS will need to comply with the rate of progress (ROP) requirement in Subpart 2 of the CAA, which applies to areas classified moderate or above. Any area not subject to the subpart 2 ROP requirement would be subject to the more general requirement under subpart 1 to make RFP. Both ROP and RFP consider progress made from a baseline inventory. As enacted in 1990, Subpart 2 provided that the base-year inventory would be 1990. See, CAA section 182(b)(1)(B). Thus, for 1-hour ozone nonattainment areas classified moderate or higher, ROP reductions for the target of 1996 were considered to be a 15 percent reduction of volatile organic compound (VOC) emissions from the 1990 baseline year. Similarly, for each three-year period following 1996 up to its attainment date, a serious or above nonattainment area was required to achieve an additional 9 percent reduction in VOC emissions.[3] Under the 8-hour ozone standard, EPA anticipates that, consistent with the above discussion, a 2002 base year emission inventory would be used as the baseline from which future target levels of emissions would be calculated. Therefore, any emission reductions that the State initiates after 2002 would be creditable toward the ROP or RFP requirements.

[3] The CAA provides that nitrogen oxides (NO) emission reductions may be substituted for VOC emission reductions for these subsequent three-year periods under prescribed circumstances. See CAA section 182(c)(2)(C).

For areas subject to the subpart 2 ROP requirement, section 182(b)(1)(D) places constraints on the use of emission reduction credits from certain pre-1990 programs even though those programs might achieve additional reductions in the years following 1990, i.e., the federal motor vehicle emission control program, Reid Vapor Pressure programs, corrections required to pre-existing reasonably available control technology (RACT) rules, and inspection and maintenance (I/M) program corrections. While these limitations would still apply for purposes of credit for SIPs designed to meet the 8-hour ozone NAAQS, EPA does not believe it is legally required and does not plan to expand the list of programs for which credit is precluded. Subpart 1 does not establish any limits on the creditability of measures for purposes of RFP and EPA does not anticipate establishing any regulatory limits on the creditability of emission reductions. Thus, EPA does not anticipate establishing any additional constraints on crediting emission reductions achieved in years following the 2002 base year. Therefore, apart from those programs listed in the CAA, we believe that States can take credit for other emission reductions that occur after the 2002 base year.

$PM_{2.5}$ NAAQS

The EPA anticipates that States will be required to implement the $PM_{2.5}$ NAAQS under Subpart 1 since the more specific provisions in Subpart 4 that address particulate matter expressly apply only to PM_{10}. As provided above, Subpart 1 does not place limits on the types of controls that are creditable for purposes of the RFP requirement. As with the 8-hour ozone NAAQS, EPA does not anticipate establishing any regulatory constraints limiting creditability of emission controls. Subpart 1 generally calls for States to submit plans including emission reduction measures designed to attain the NAAQS within 3 years after a nonattainment designation. It also includes a reasonable further progress (RFP) requirement, but does not have a specific percent reduction requirement as there is in the ROP requirement of Subpart 2. The exact form of the RFP requirement for $PM_{2.5}$ has yet to be established, but it is expected that any emission reductions that occur after the base year of 2002 would be credited toward the emission reductions needed by the State under its attainment demonstration and toward the reductions needed to meet the RFP requirement.

Regional Haze Program

The regional haze program calls for States participating in regional planning organizations to submit SIPs in 2007-8 that contain progress goals for every class I area and emission reductions strategies needed to meet these goals. Progress in improving visibility is tracked from baseline conditions (established using air quality monitoring for the 2000-2004 period). If 2002 is used as the base year for planning purposes, then States can take credit for emission reductions that are achieved before the 2007-2008 SIP due date.

Credits in General

It should be noted that EPA cannot provide "double credit" for an emission reduction for purposes of RFP or ROP. For instance, if a program or rule results in emission reductions prior to or in the base year, those reductions would be considered in calculating the base year emissions inventory and thus could not be counted as emission reductions from the base-year level. Such reductions would likely lower ambient pollutant concentrations, however, and would be important in terms of determining an area's designation and, if designated nonattainment, could affect the area's classification and thus its planning obligations. For example, emission reductions in NOx or VOC achieved prior to or during 2002 could have already resulted in the area having a lower ozone design value, which is the measure of whether the area is violating the 8-hour ozone standard and, if so, by how much. Reductions from such measures in years beyond the base year would be creditable towards ROP SIPs. These concepts of credit were discussed in the January 29, 2001, memorandum from John Seitz entitled "Near-Term Discretionary Emission Reductions for Ozone NAAQS–Clarification," which addressed the 1-hour ozone standard, but which are also conceptually applicable to implementation of the 8-hour ozone standard.

However, post-2002 emission reductions that benefit ozone, PM2.5 and regional haze can be credited toward the RFP requirements for each of these programs.