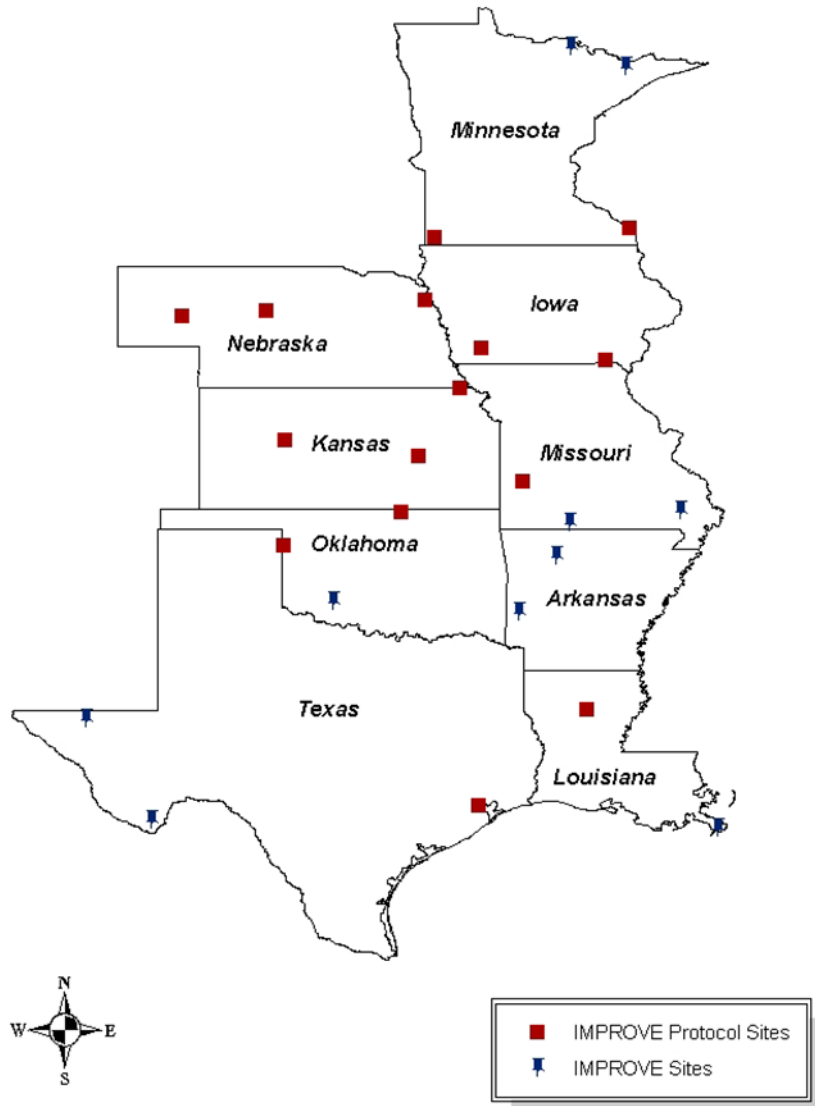# Modeling Subgroup NAAQS SIP Meeting

Arkansas Department of Environmental Quality

February 10, 2015

IMPROVE Sites

- Interagency Monitoring of Protected Visual Environments (IMPROVE)

- IMPROVE sites
  - provide chemical speciation data for $PM_{2.5}$
  - provide data for assessing visibility at Class 1 areas

- Arkansas IMPROVE sites
  - Upper Buffalo Wilderness Area
  - Caney Creek

PM$_{2.5}$ Composition

▸ PM$_{2.5}$ is composed of several species of compounds:

  ▸ Sulfate

  ▸ Nitrate

  ▸ Organic Carbon

  ▸ Elemental Carbon

  ▸ Crustal

  ▸ Other

PM$_{2.5}$ Speciation Data Overview
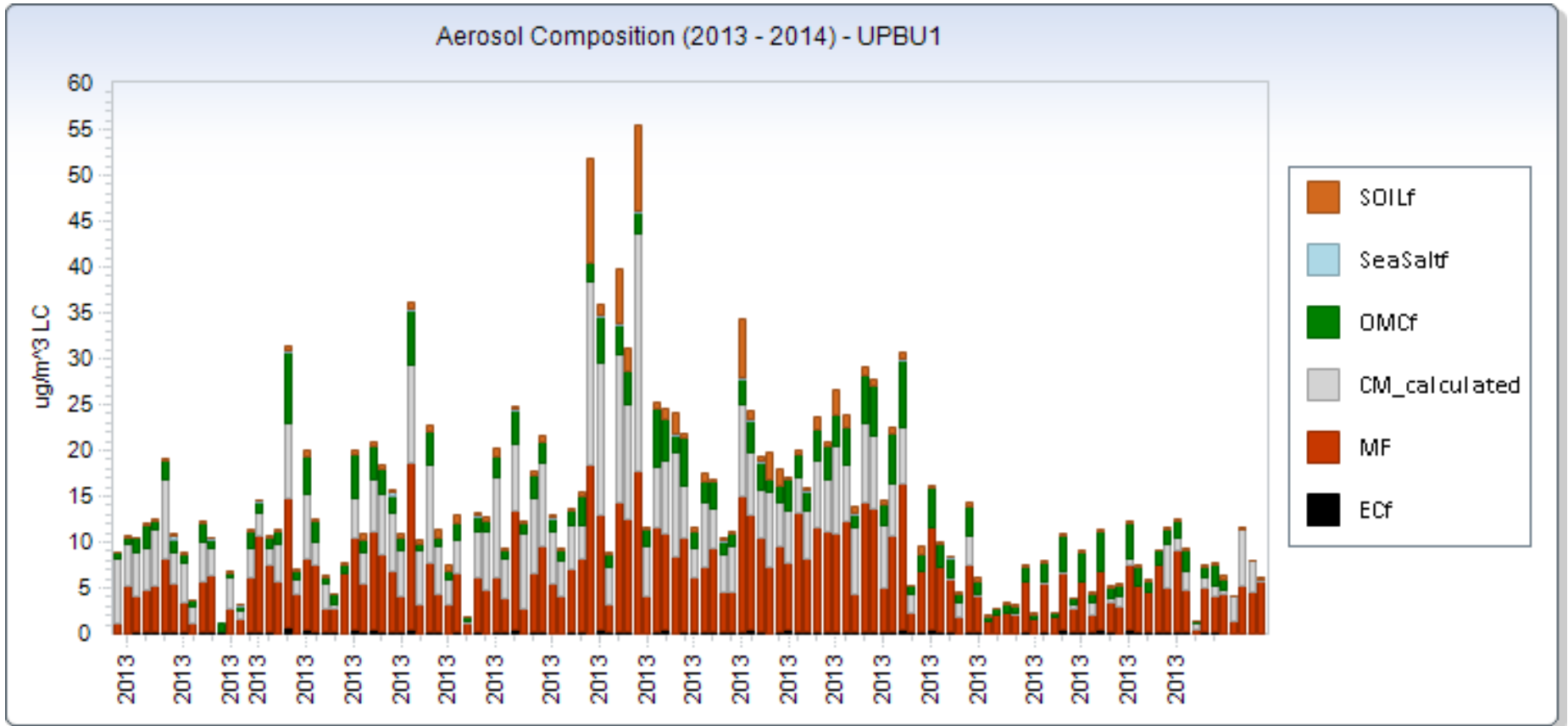
Upper Buffalo Wilderness Area

Federal Land Manager Environmental Database (FED)

Home   **Summaries**   **Data**   **Metadata**   **Resources**

Choose a network or dataset:

IMPROVE Aerosol

Latitude:37.34291, Longitude:-63.36914, Zoom Level: 4

Reset view

Get site metadata as a delimited text file

| Site	Code	CT	ST	EPACode	Lat	Lon	Elev	Start	End
3425 N First St, Fresno	FRES1	US	CA	060190008	36.782	-119.773	100	2004	2013
Acadia NP	ACAD1	US	ME	230090103	44.377	-68.261	157	1988	2013
Addison Pinnacle	ADPI1	US	NY	361019000	42.091	-77.21	512	2001	2010
Agua Tibia	AGTI1	US	CA	060659000	33.464	-116.971	508	2000	2013
Ambler	AMBL1	US	AK	021889000	67.099	-157.863	78	2003	2004
Arches NP	ARCH1	US	UT	490190101	38.783	-109.583	1722	1988	1999
Arendtsville	AREN1	US	PA	420019000	39.923	-77.308	267	2001	2010
Badlands NP	BADL1	US	SD	460710001	43.743	-101.941	736	1988	2013
Baengnyeong Island	BYIS1	KR			37.966	124.631	100	2013	2013
Baengnyeong Island Co-located A Module	BYISX	KR			37.966	124.631	100		
Baltimore	BALT1	US	MD	240059000	39.255	-76.709	78	2004	2006
Bandelier NM	BAND1	US	NM	350281002	35.78	-106.266	1988	1988	2013
Barrier Lake	BALA1	CA	AB					2011	2013
Big Bend NP	BIBE1	US	TX	480430101	29.303	-103.178	1067	1988	2013
Bliss SP (TRPA)	BLIS1	US	CA	060179000	38.976	-120.103	2131	1990	2013
Blue Mounds	BLMO1	US	MN	271339000	43.716	-96.191	473	2002	2013
Bondville	BOND1	US	IL	170191001	40.052	-88.373	263	2001	2013
Bosque del Apache	BOAP1	US	NM	350539000	33.87	-106.852	1390	2000	2013
Boulder Lake	BOLA1	US	WY		42.85	-109.64	2296	2009	2013
Boundary Waters Canoe Area	BOWA1	US	MN	270759000	47.947	-91.496	527	1991	2013

5

📁 **Reductions in haze across the United States since the early 1990s Visualized using WinHaze Simulated Photographs** - The effects of the changes in the 20% haziest days on the scene for ~50 national parks and wilderness were simulated using WinHaze. The haziest reconstructed bext values corresponding to the beginning and end of trend periods for each site as estimated using IMPROVE data were input into WinHaze to visualize the changes in the scene.

📁 **Apportionment of Biomass Burning Contribution to Haze and PM2.5** - This project was designed to develop better tools to apportion the contributions of biomass burning from different fire types, e.g. wildfires and prescribed fires to PM2.5 and haze. As part of this study a retrospective hybrid-receptor model based on the positive matrix factorization (PMF) model was developed. The project was partially funded by the Joint Fire Science Program.

📁 **IMPROVE Coarse Mass Speciation Study** - To more fully investigate the composition of coarse particles, a program of coarse particle sampling and speciation analysis at nine of the IMPROVE sites was initiated between 19 March 2003 and 23 December 2003, with each site operating for one year.

📁 **Yosemite Aerosol Characterization Study** - The Yosemite Aerosol Characterization Study (YACS) was an intensive field measurement campaign conducted by a number of U.S. research groups from 15 July to 4 September 2002 at Yosemite National Park (NP), California.

📁 **Big Bend Regional Aerosol and Visibility Observational Study (BRAVO)** - The BRAVO study is designed to investigate the causes of haze at the Big Bend National Park. The network operated from July to October, 1999 measuring fine aerosol mass and its constituents, atmospheric optical properties, gaseous air pollutants and meteorology at Big Bend.

📁 **Southeastern Aerosol and Visibility Study (SEAVS)** - This study measured aerosols under humid Southeastern US conditions to determine the contribution of major aerosol constituents, including water, to the total particle mass and light extinction. Field measurements included particle size, water and optics, aerosol composition, meteorology and human perception of scenes at the Great Smoky Mountains National Park over a 6 week period during the summer of 1995.

📁 **Measurement of Haze and Visual Effects (MOHAVE)** - This network was established to help determine the contributions of the Mohave Power Plant and other sources to haze at Class I areas in the Southwestern US. The MOHAVE network employed 43 IMPROVE type samplers in the Southwest collecting daily particulate samples over a 24 hour period. The network collected data over a winter and summer period from 1/10/–2/15/92 and 7/11/–9/2/92 respectively. The particulate samples were analyzed for PM2.5 and its elemental constituents, organics, ions, light absorption and PM10.

📁 **The Pacific Northwest Regional Visibility Experiment Using Natural Tracers (PREVENT)** - This network was established to study visibility causes and effects in Washington state, west of the Cascades. The network consisted of 34 monitors located in Washington and Oregon. Daily particulate samples were collected from 6/90–9/90 and analyzed for PM2.5 mass and its elemental constituents and light absorption.

📁 **The Winter Haze Intensive Tracer Experiment (WHITEX)** - This study was established to study the visibility impacts of emissions from the Navajo Generating Station. The database contains data from 13 locations which sampled from 1/1/87 – 2/18/87. Samples were collected every 6, 12, and 24 hours depending on the site and sampler. The particulate samples were analyzed for PM2.5 mass and its elemental constituents, organics, ions, and light absorption.

📁 **The Mt. Zirkel Visibility Study (MZVS)** - A visibility study designed to determine the extent of visibility impairment at the Mt. Zirkel Wilderness Area and contribution of the major sources responsible for any visibility impairment.

📁 **The Navajo Generating Station Visibility Study (NGS)** - The NGS Visibility Study was conducted by the SRP, the operators of NGS, from January 10 through March 31, 1990. Its purpose was to address visibility impairment in Grand Canyon National Park during the winter months and the levels of improvement that might be achieved if SO2 emissions from NGS were reduced. The study was performed to provide input to the rulemaking process of the EPA regarding NGS SO2 controls. Perfluorocarbon tracers (PFT) were released from the three stacks of NGS. Surface and upper air meteorology, particle and gaseous components, and tracer were measured at many sites. The study concluded that the NGS plume was not present at Hopi Point for most of the days. The tracer data quality from this experiment was insufficient for quantitative source apportionment and the results emphasized the need for better tracer measurements in future studies.

Five-Year Trend in Annual PM$_{2.5}$ Design Values
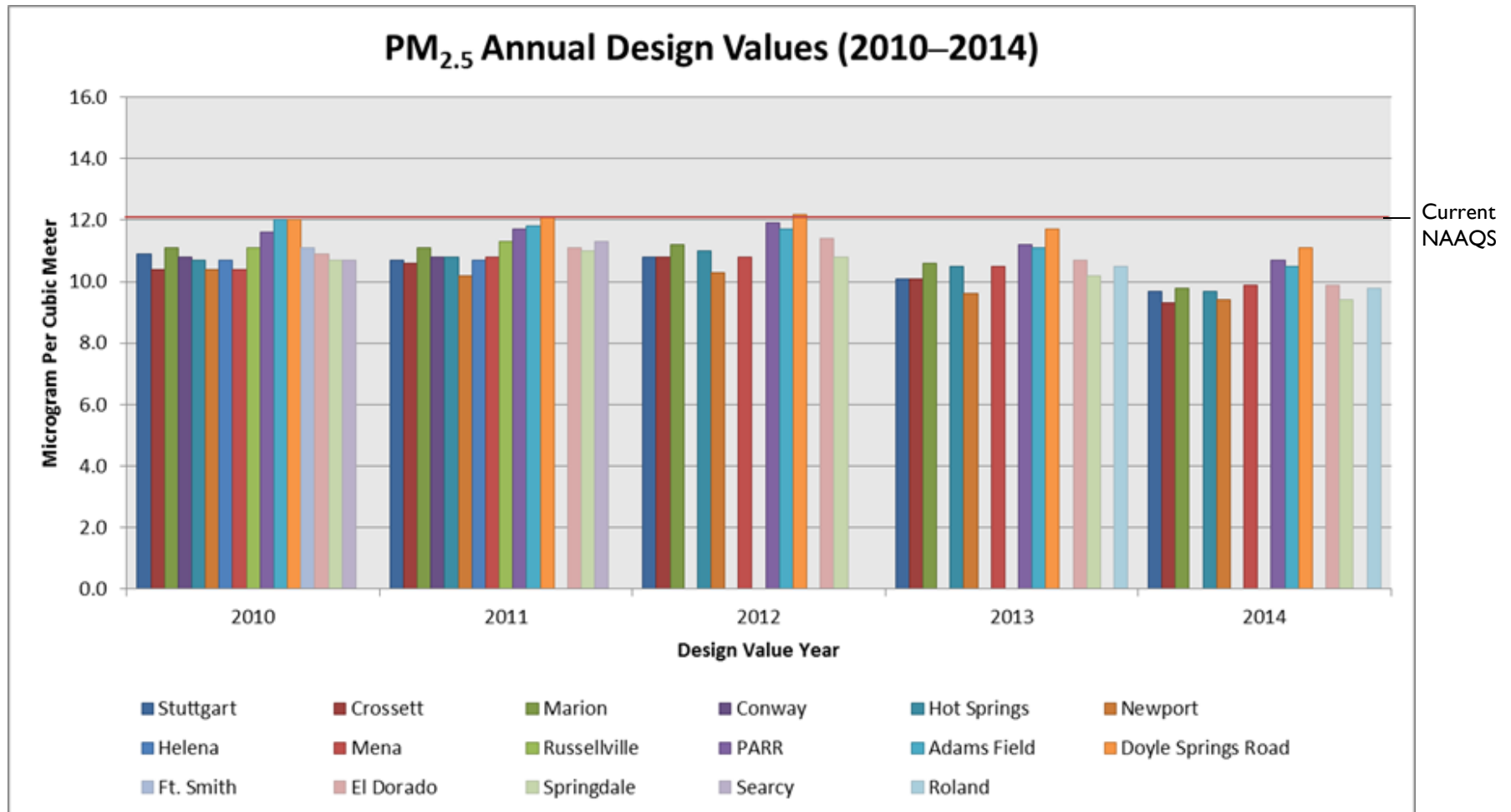
Monitor Data Trend Analysis

Trend Analysis for PM2.5: Marion (05-035-0005)
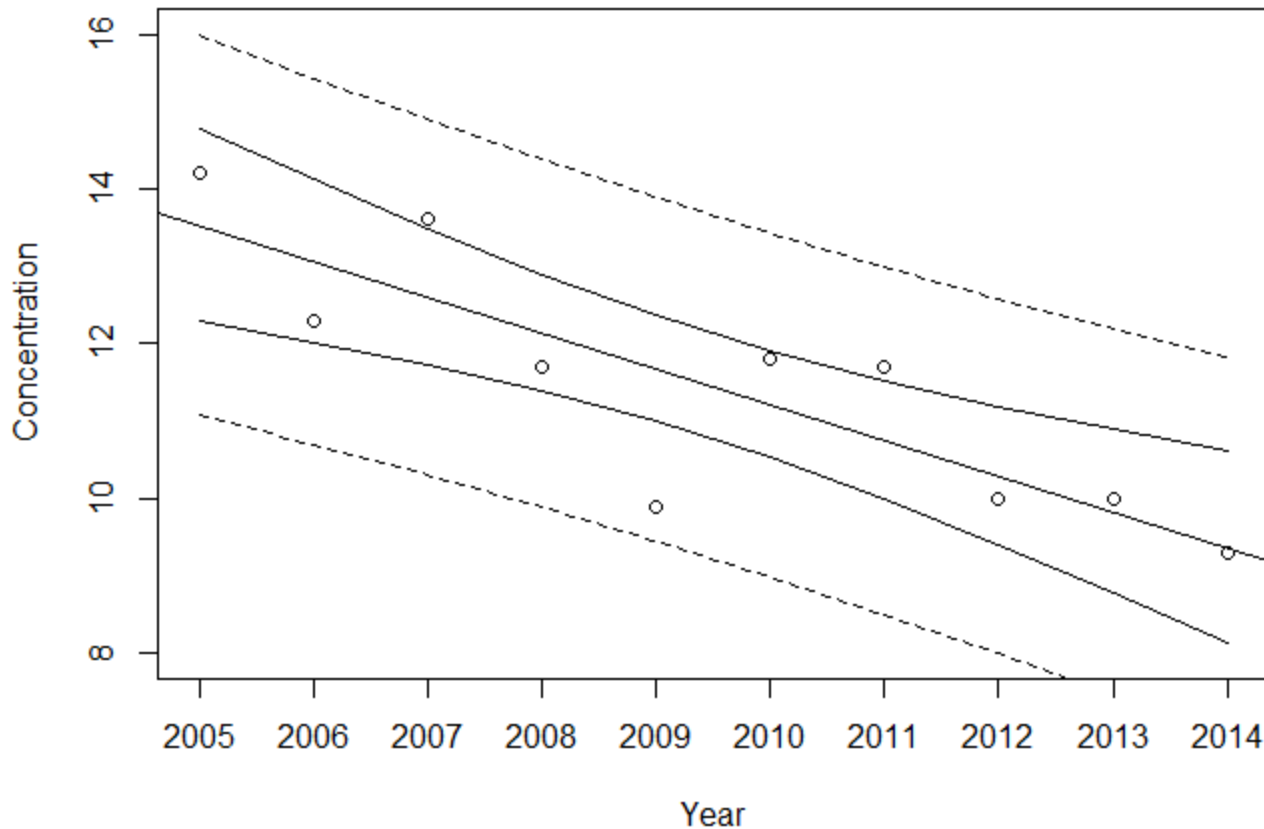
Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) 940.6915   203.1233 4.631 0.00169 **

Year   -0.4624   0.1011 -4.575 0.00181 **

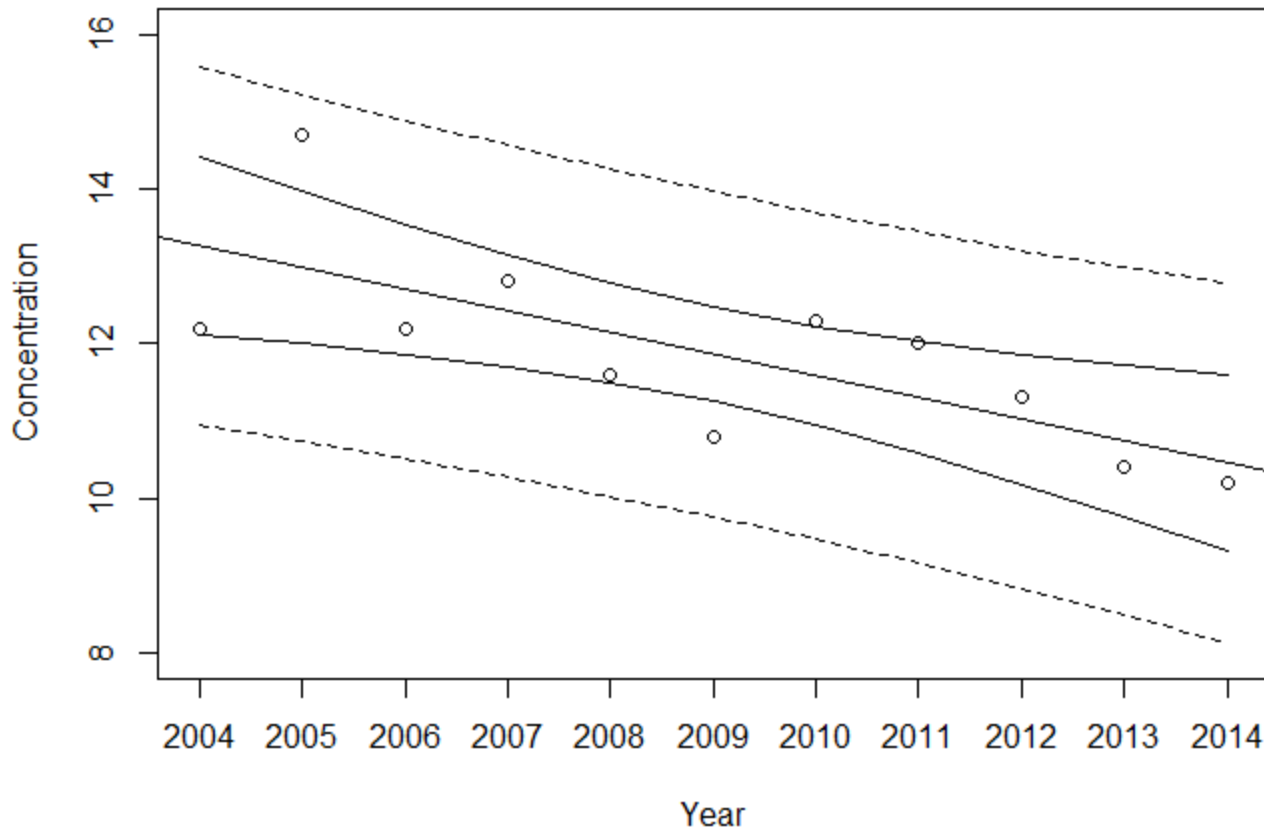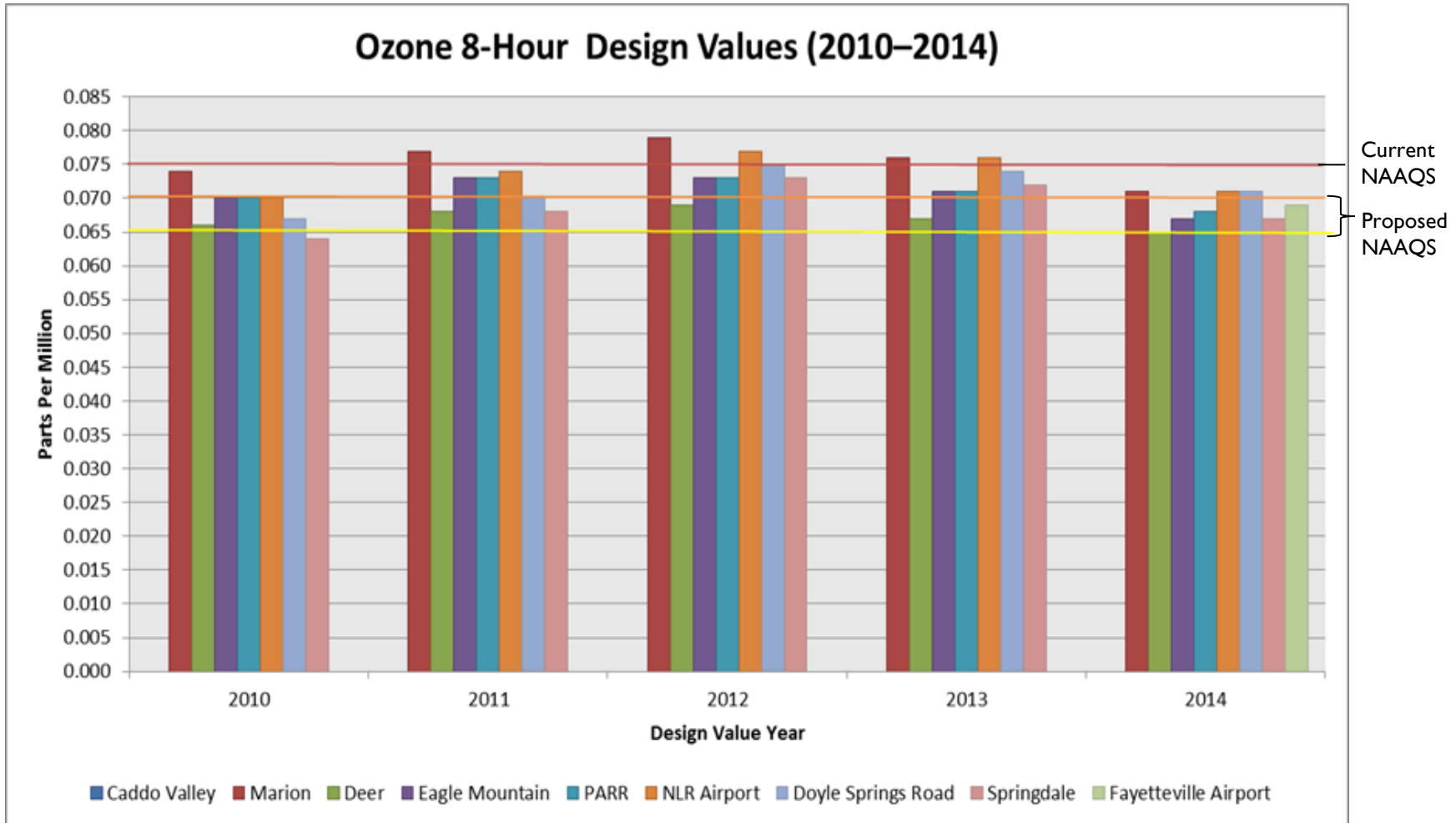Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9181 on 8 degrees of freedom
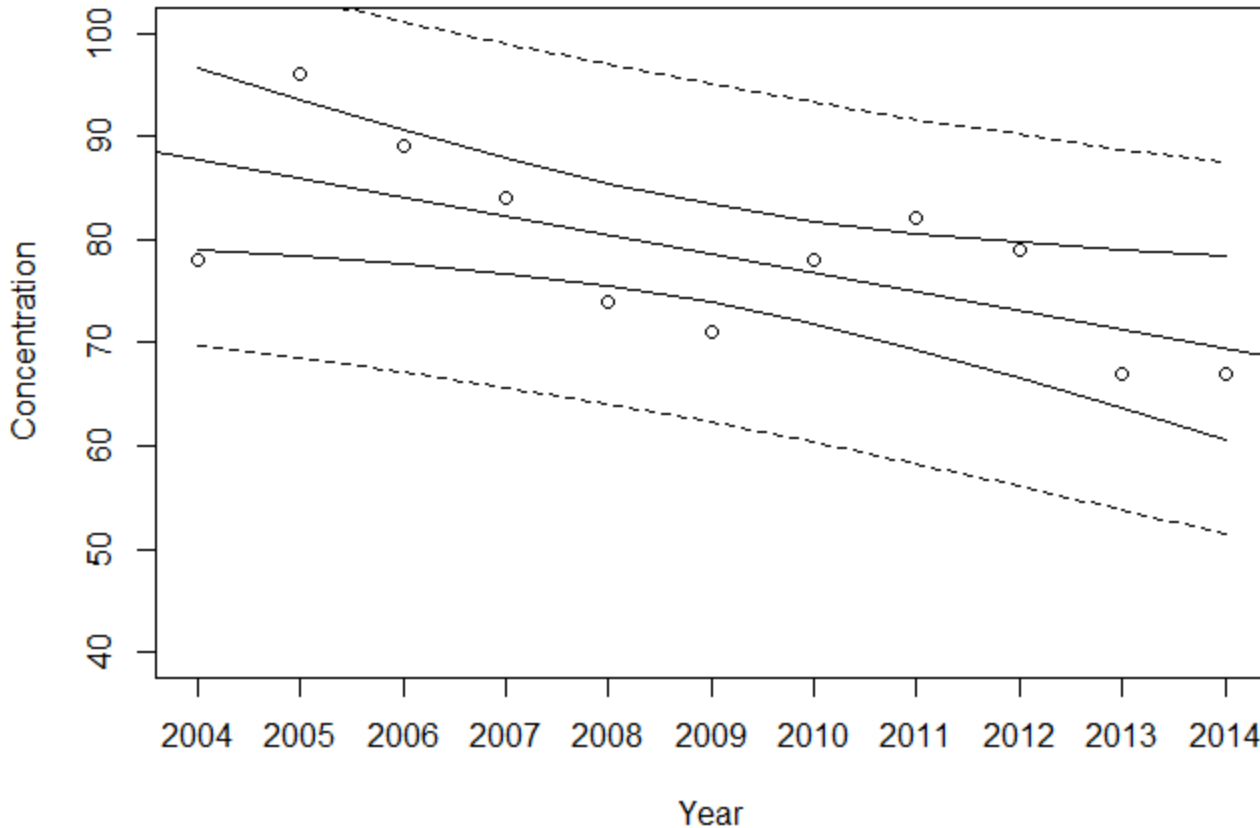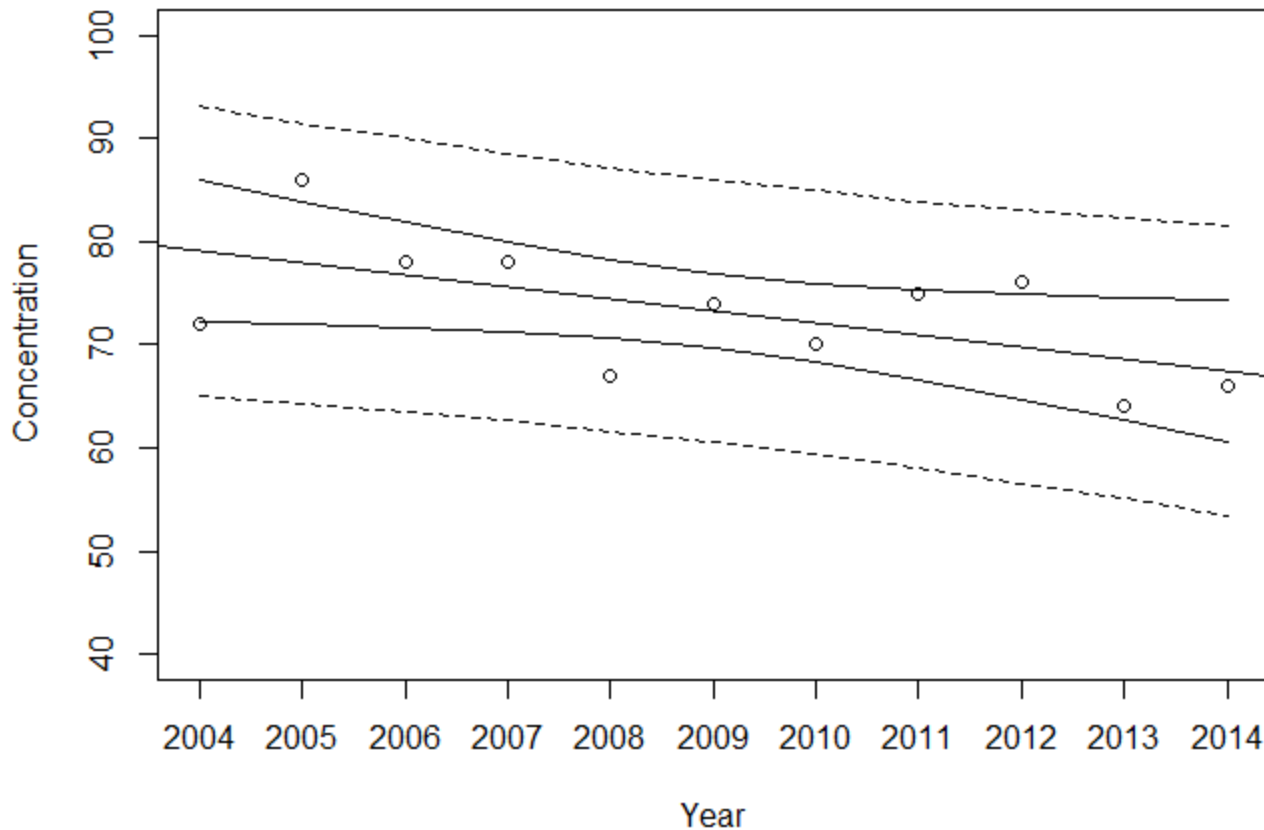
Multiple R-squared: 0.7235, Adjusted R-squared: 0.6889

F-statistic: 20.93 on 1 and 8 DF, p-value: 0.001814

Monitor Data Trend Analysis

Trend Analysis for PM2.5: PARR (05-119-0007)

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) 574.38364 170.86909 3.362 0.00837 **

Year   -0.28000   0.08505 -3.292 0.00935 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.892 on 9 degrees of freedom

Multiple R-squared: 0.5463, Adjusted R-squared: 0.4959

F-statistic: 10.84 on 1 and 9 DF, p-value: 0.009347

Five-Year Trend in 8-hour Ozone Design Values

Monitor Data Trend Analysis

Trend Analysis for Ozone: Marion (05-035-0005)

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) 3749.6273 1329.0429 2.821   0.020 *

Year   -1.8273   0.6615 -2.762   0.022 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.938 on 9 degrees of freedom

Multiple R-squared: 0.4588, Adjusted R-squared: 0.3987

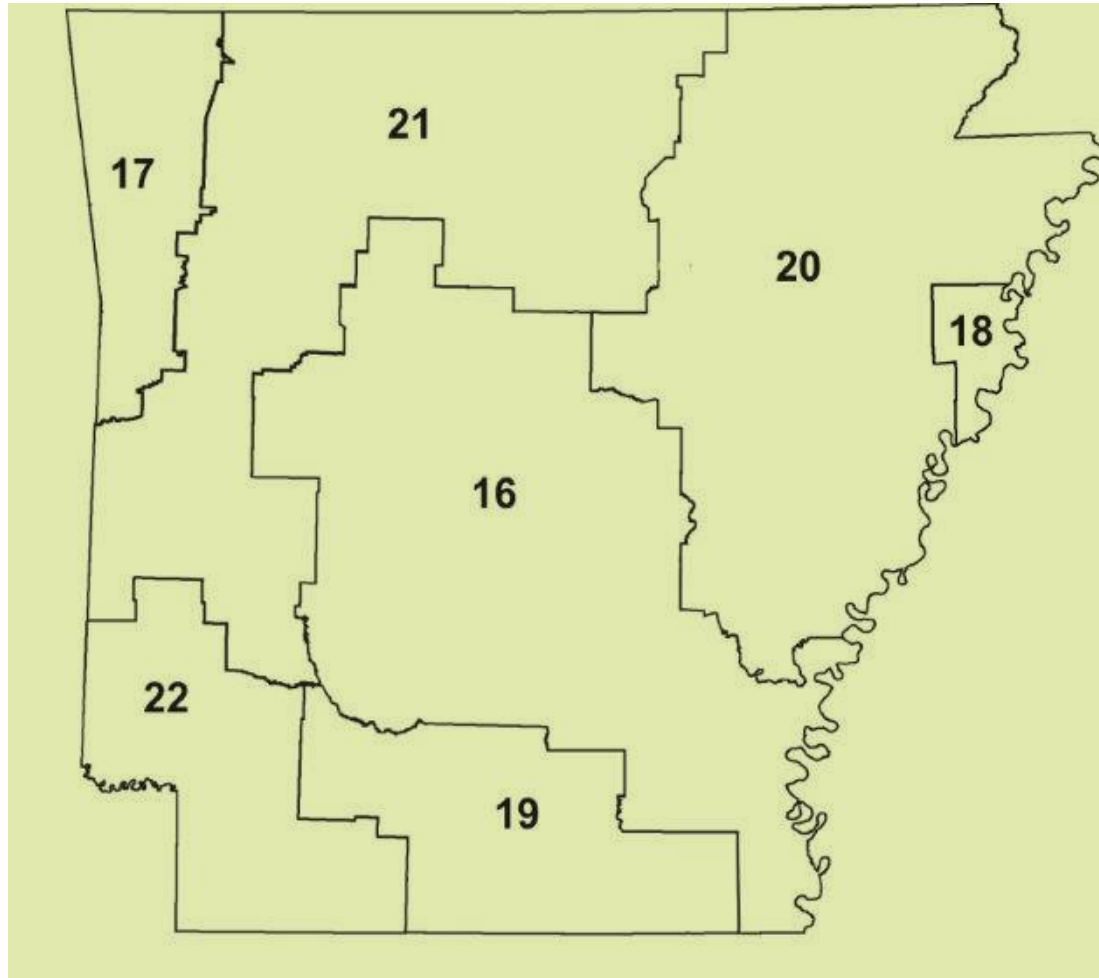F-statistic: 7.629 on 1 and 9 DF, p-value: 0.02204

Monitor Data Trend Analysis

Trend Analysis for Ozone: PARR (05-119-0007)

Coefficients:

Estimate Std. Error t value Pr(>|t|)

(Intercept) 2392.755   1032.628   2.317   0.0457 *

Year   -1.155   0.514 -2.246   0.0513 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.391 on 9 degrees of freedom

Multiple R-squared: 0.3592, Adjusted R-squared: 0.288

F-statistic: 5.045 on 1 and 9 DF, p-value: 0.05132

Monitor Data Trend Influences
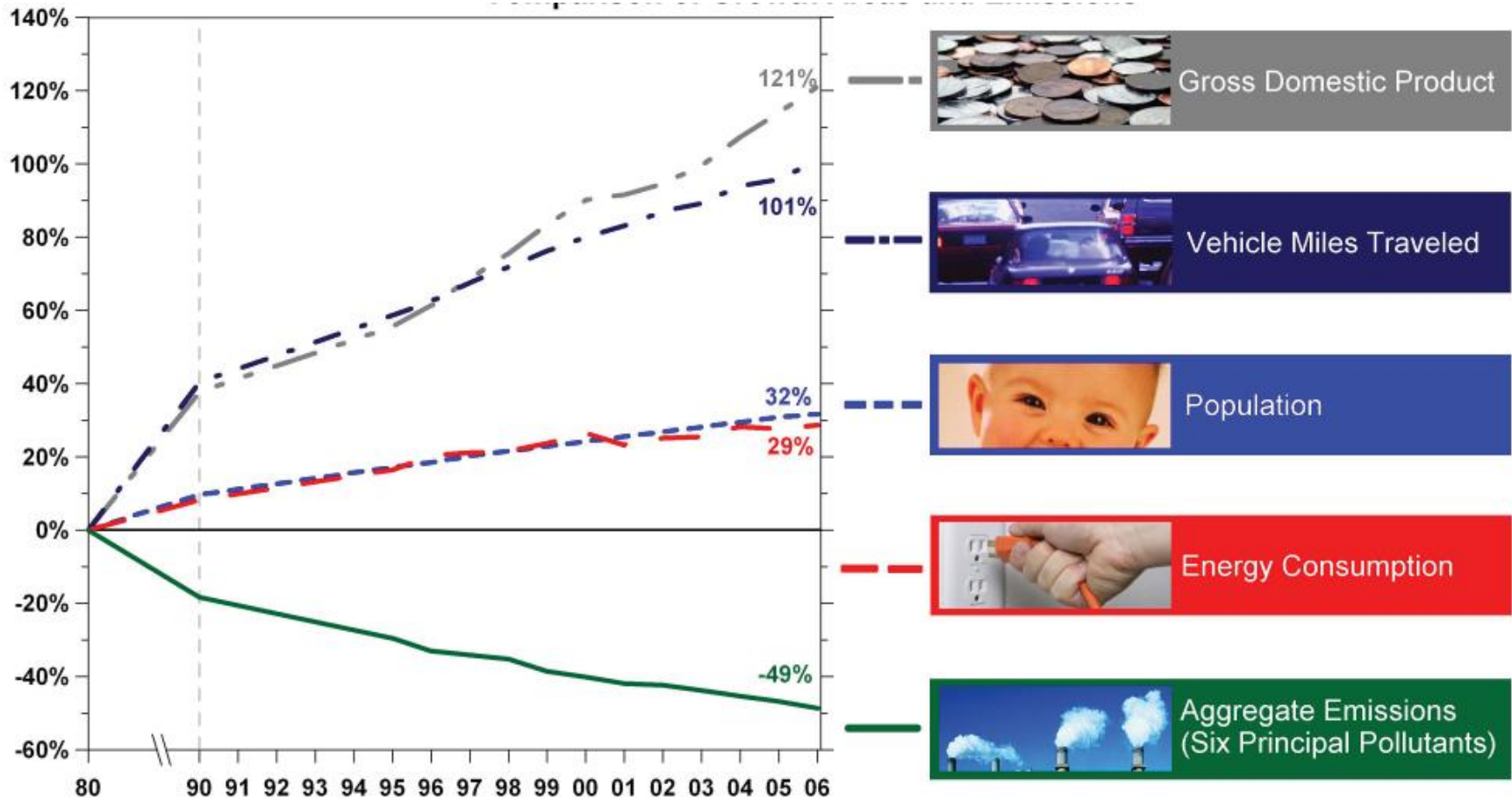
Comparison of national growth measures and emissions, 1980-2006.

Statewide vs Intrastate Regional Approach

- Arkansas Air Quality Regions
- Arkansas Planning and Development Districts
- County Level
- Permitted Facility Locations
- 4 Kilometer Grid

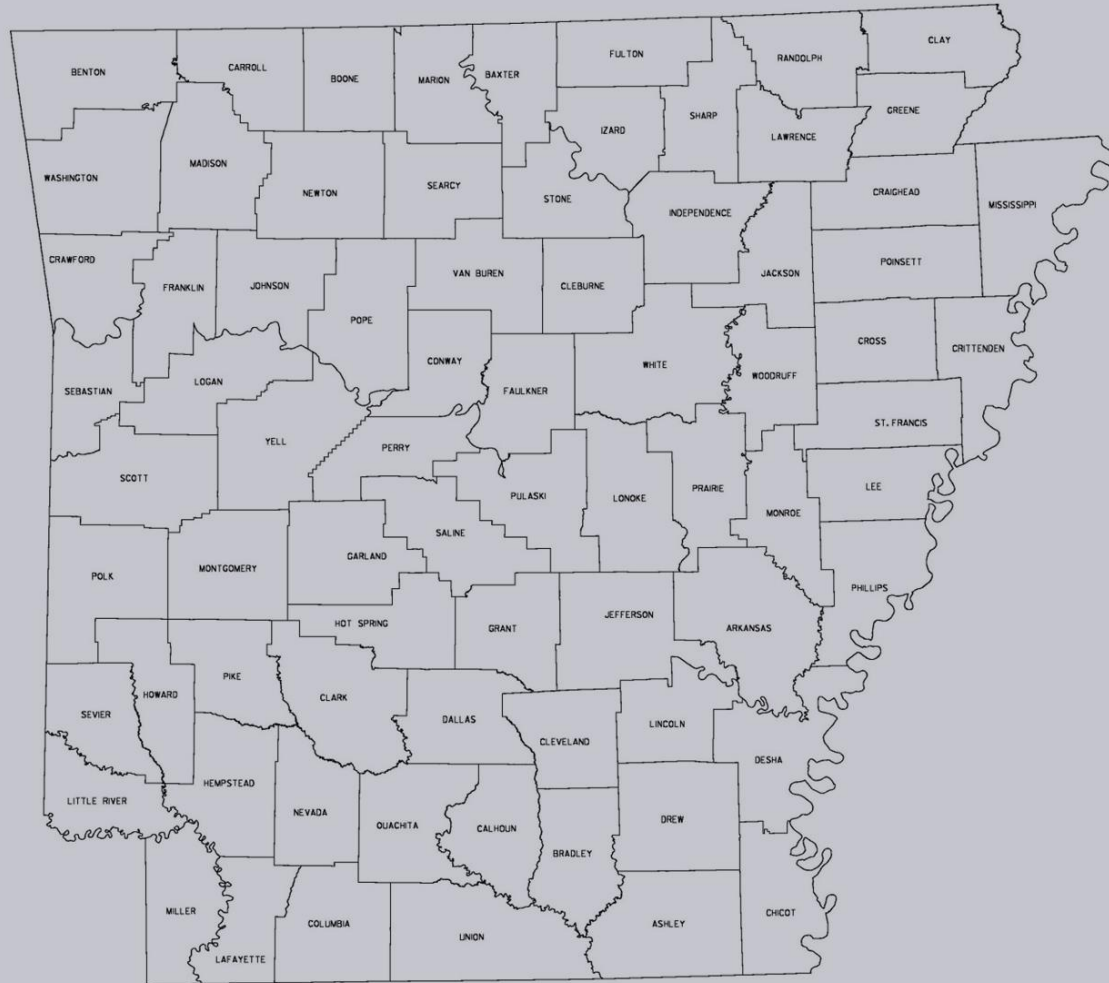# **Arkansas Air Quality Regions**

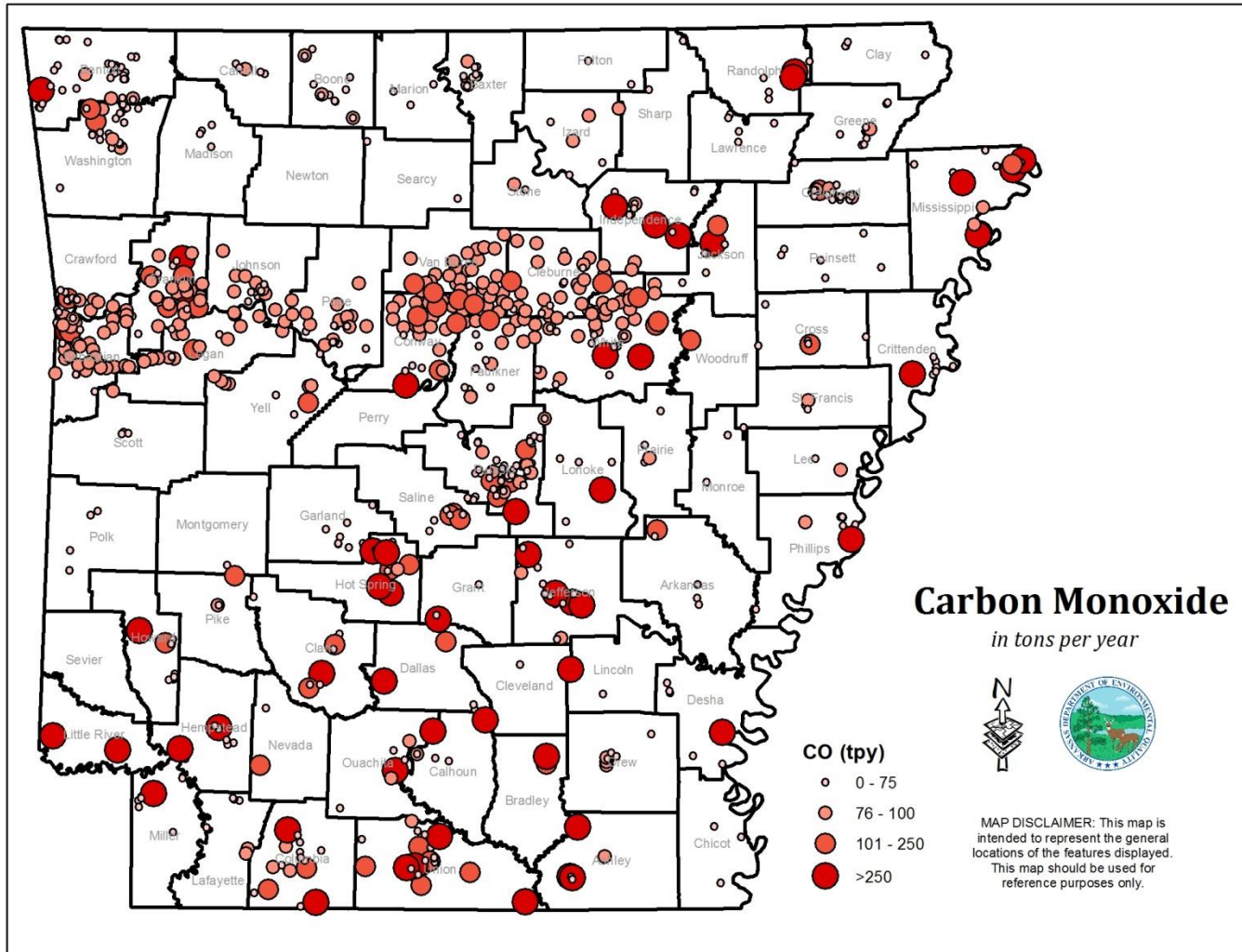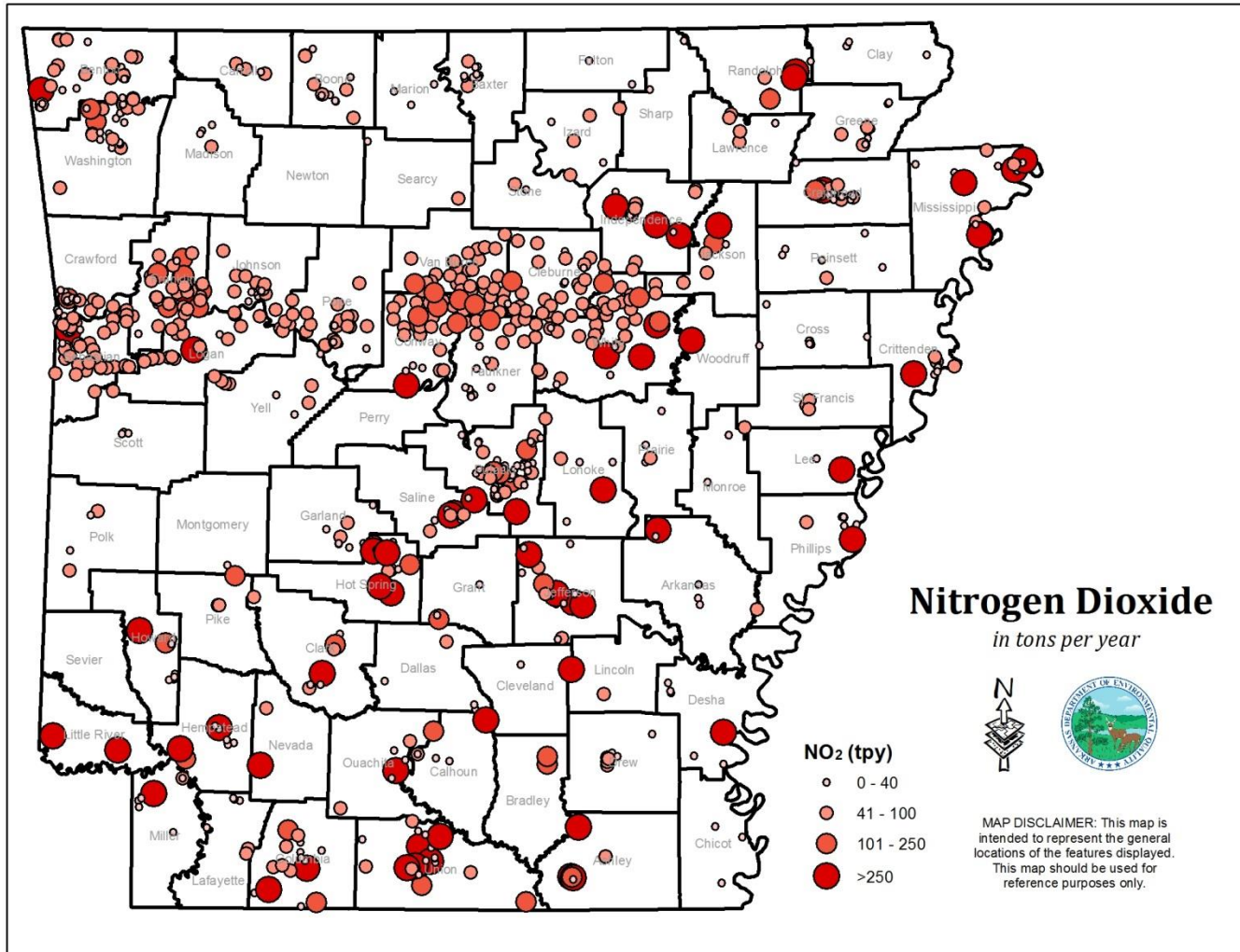# Arkansas Planning and Development Districts

County Level

Permitted CO Facilities

Carbon Monoxide
in tons per year

CO (tpy)
- 0 - 75
- 76 - 100
- 101 - 250
- >250

MAP DISCLAIMER: This map is intended to represent the general locations of the features displayed. This map should be used for reference purposes only.

Permitted NO$_2$ Facilities

Permitted SO$_2$ Facilities
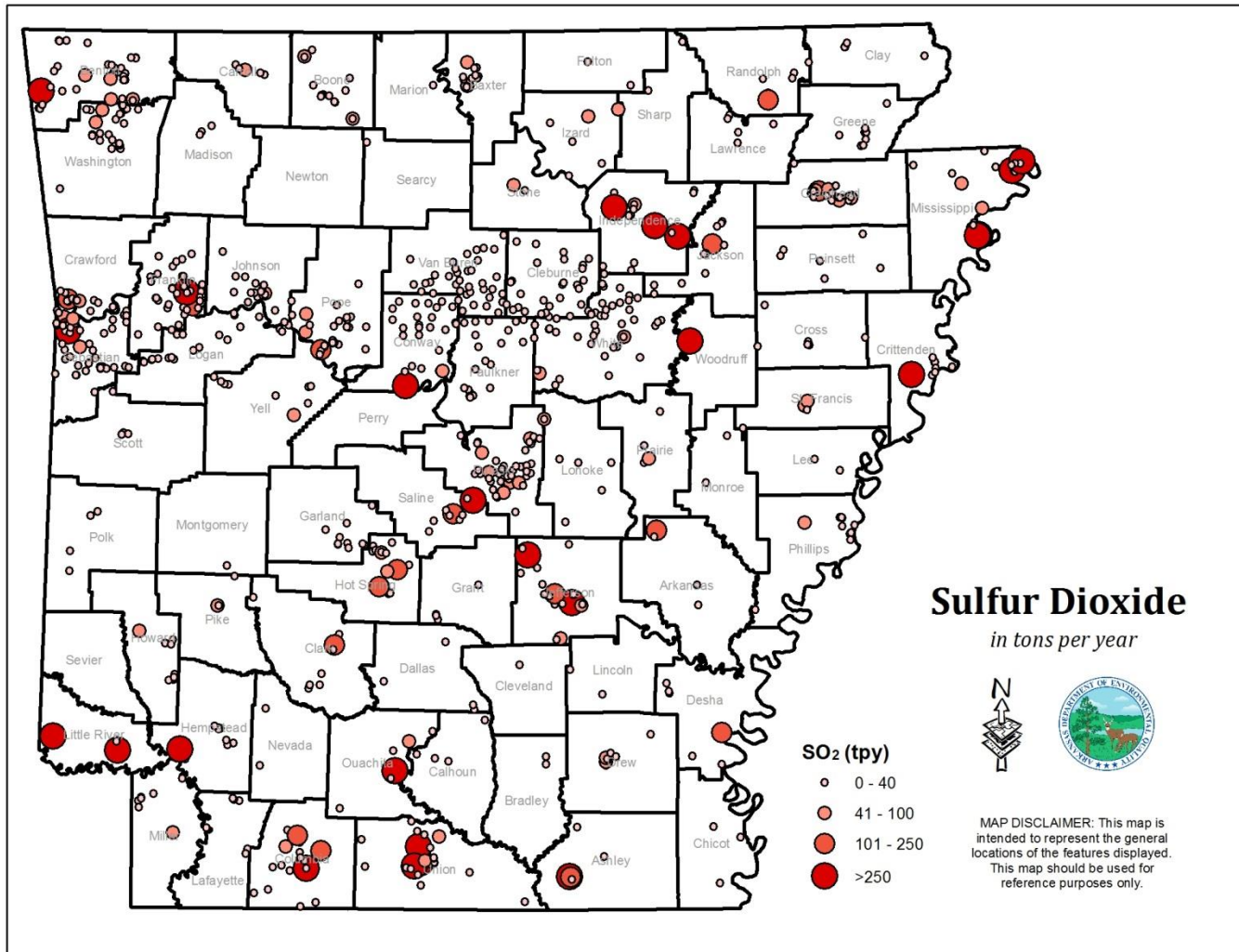
Permitted PM$_{10}$ Facilities
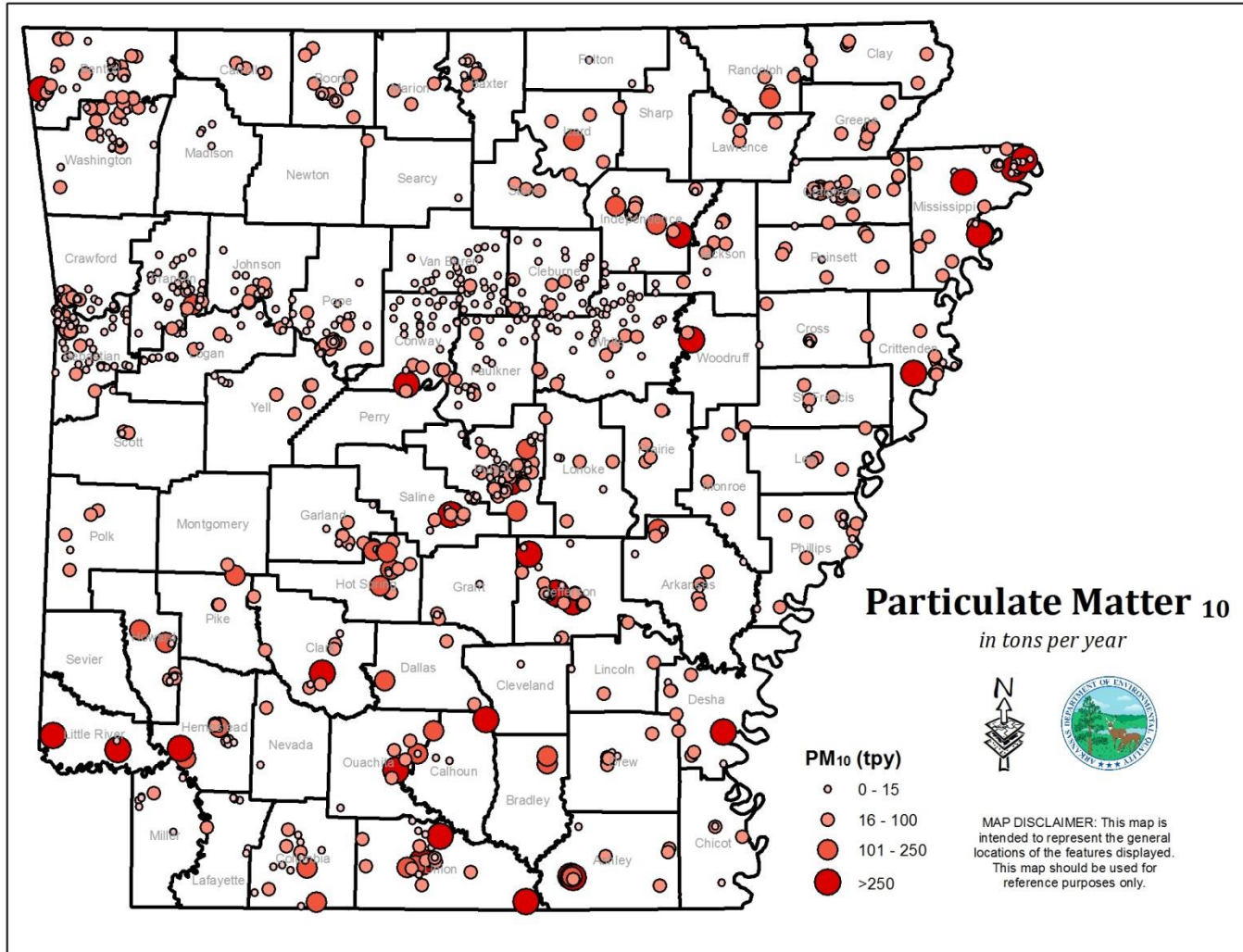
Permitted VOC Facilities
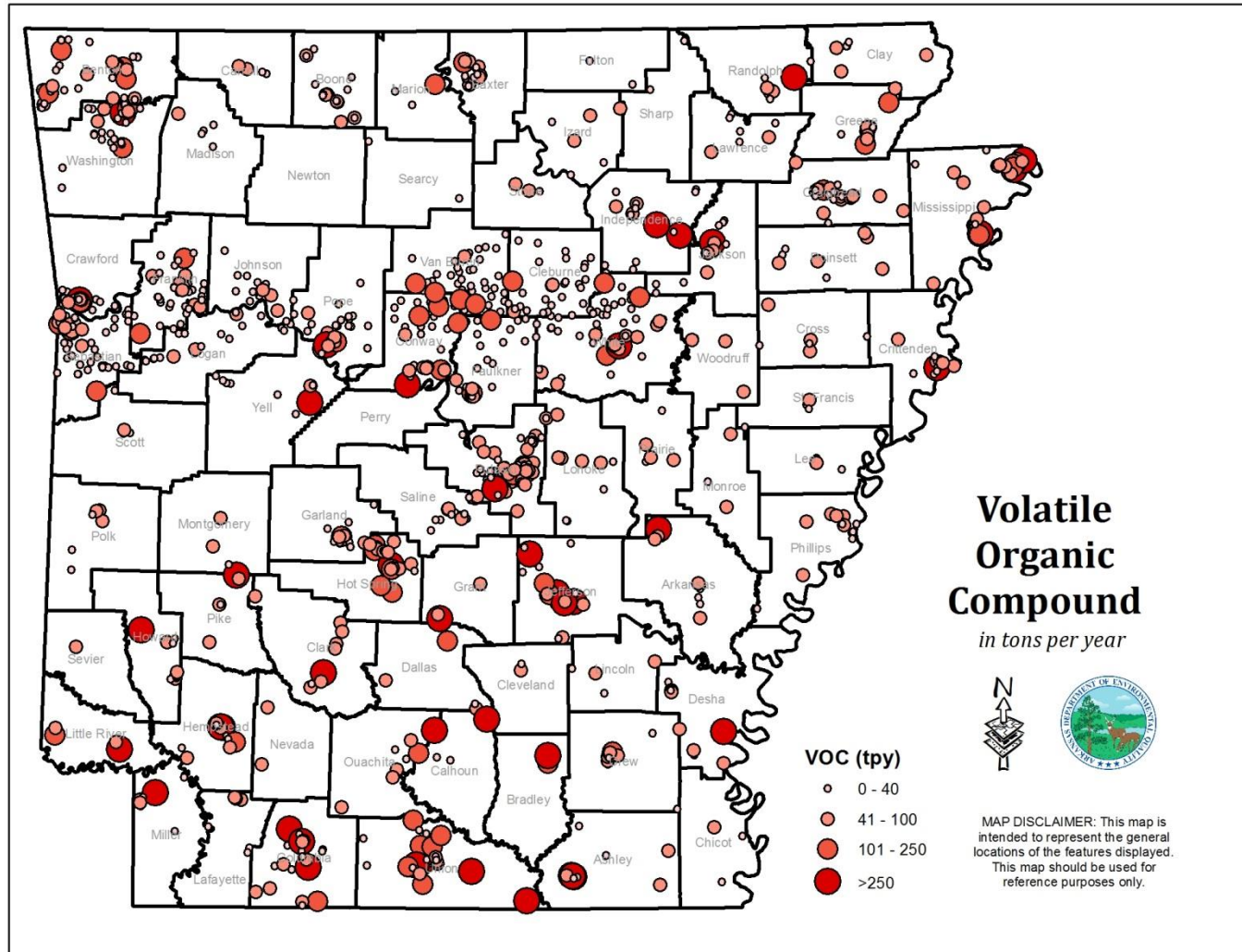
4 Kilometer Grid
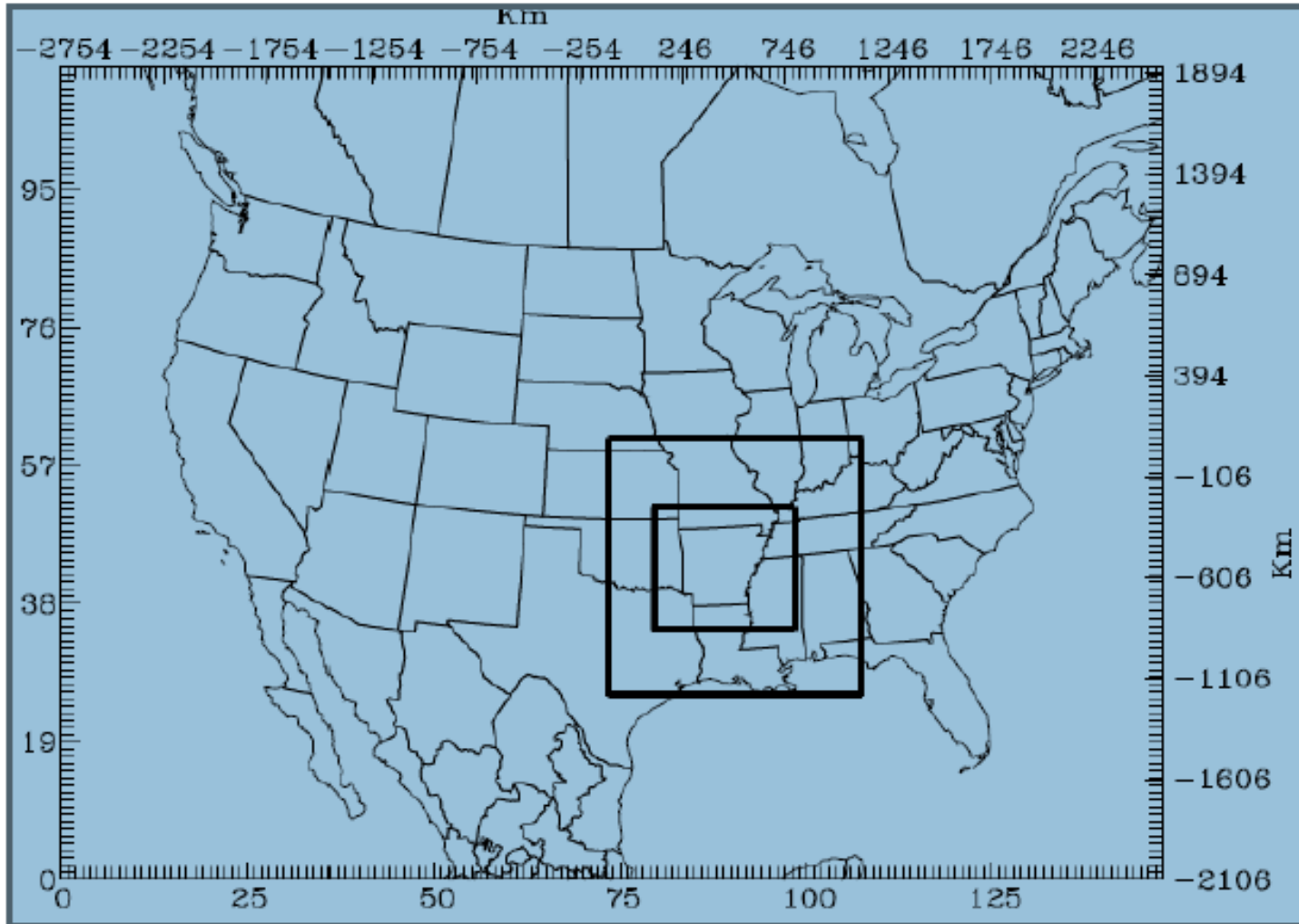
4 Kilometer Grid
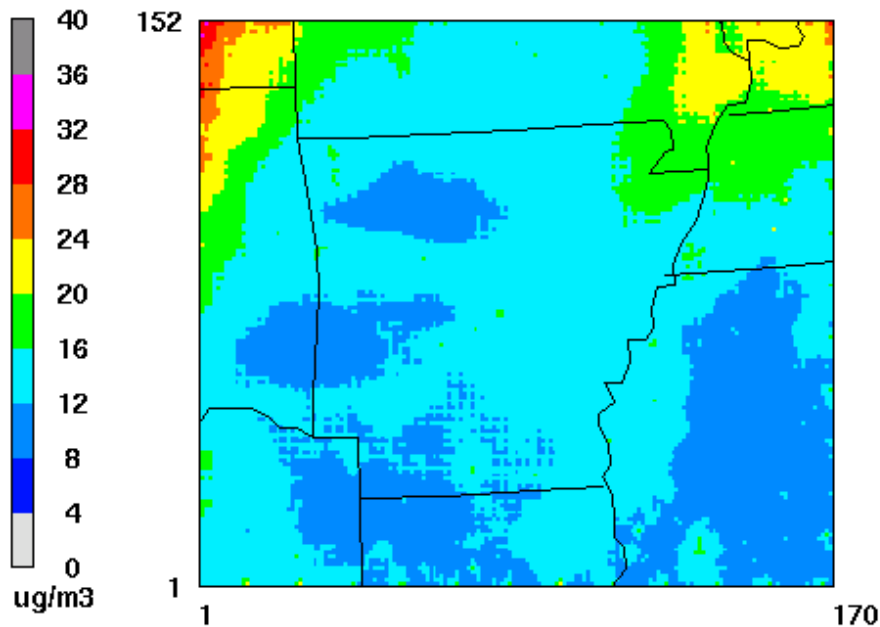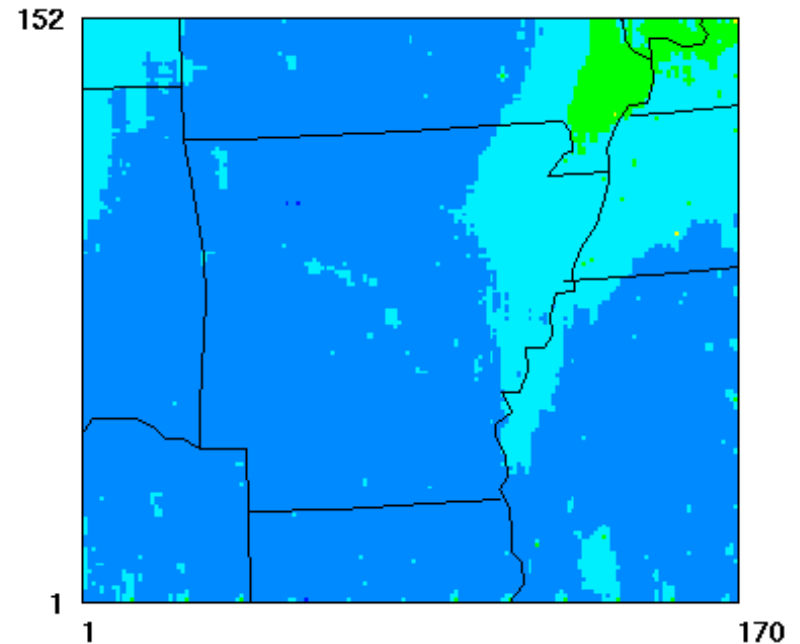
NAAQS

Pollutant / Averaging Time

5 Year regional model with growth maintains NAAQS? —— No —→ Develop control/ maintenance strategy. —→ ?

Yes

Evaluate past individual source modeling. Past modeling issues? —— No —→ Is past model representative of most future situations? —— Yes → End

Yes

No

Can be resolved by standard conditions or control strategies? —— No —→ Require modeling

Evaluate outlier situations?

Yes

Implement Strategies in Regulations?

Propose controls/ cases for modeling.

Remaining issues/ situations? —— No

Yes

Require modeling for specific situations.

Arkansas Ambient Air Monitoring Network

Present Network
- SO2
- CO
- Ozone
- NOx
- PM 10
- PM2.5 FRM
- PM2.5 TEOM Continuous
- IMPROVE
- PM2.5 Speciation
- NCORE Site

Additional Monitors

Should additional monitors be deployed?

Where should new monitors be added?

Challenges:

- Additional Costs

Benefits:

- Ambient Data vs Modeled Data
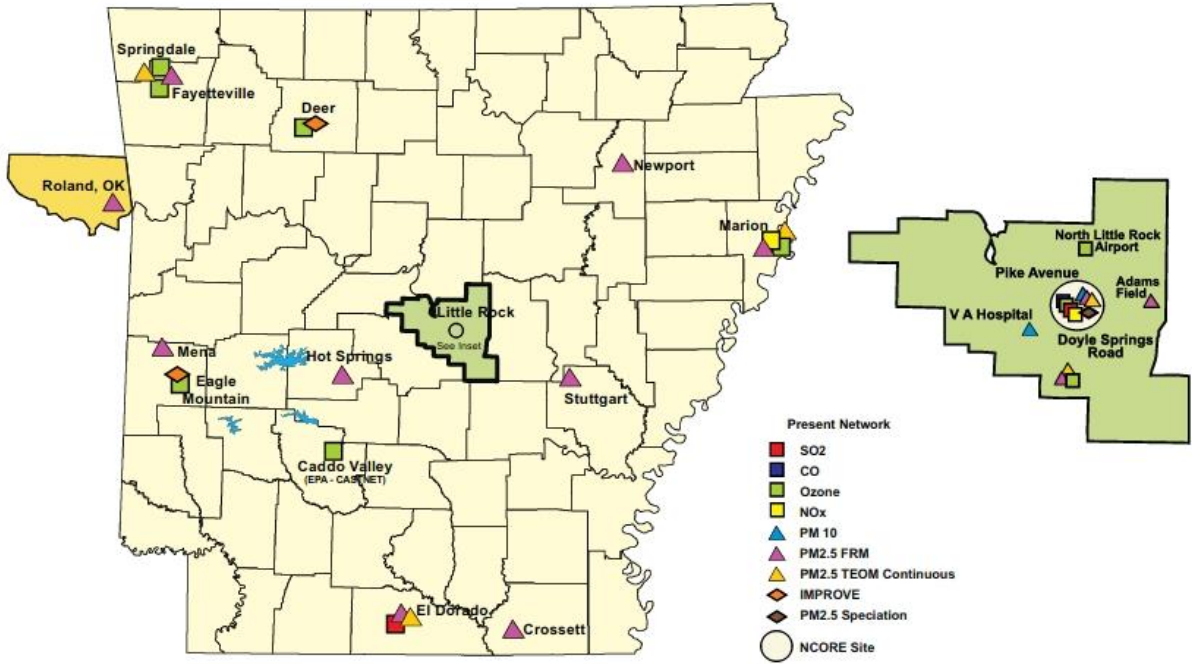
PARR Site

For Additional Information:

▶ **Tony Davis**

Air Planning Branch Manager

Arkansas Department of Environmental Quality

(501) 682-0728

davisa@adeq.state.ar.us