Fine Particle Attainment Demonstration and Technical Support Document

For Central Indiana

Hamilton, Hendricks, Marion, Morgan and Johnson Counties, Indiana

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1.0 OVERVIEW

1.1 INTRODUCTION

Particulate matter is one of six criteria air pollutants that scientists have identified as being particularly harmful to humans and the environment. National Ambient Air Quality Standards (NAAQS) have been developed for these six pollutants and are used as measurements of air quality. Fine particles and precursor pollutants are emitted by a wide range of sources, including power plants, cars, trucks, industrial sources and other burning or combustion-related activities.

1.2 NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)

The Clean Air Act Amendments of 1990 (CAAA) requires areas designated nonattainment for a National Ambient Air Quality Standard (NAAQS) to develop State Implementation Plans (SIPs) to expeditiously attain and maintain the standard. In 1997, the United States Environmental Protection Agency (U.S. EPA) set daily and annual air quality standards for fine particles (fine particulate matter), as shown in Table 1.1 below. The standards were legally challenged and upheld by the U.S. Supreme Court in February of 2001. In 1999 Indiana began monitoring for fine particle concentrations. The U.S. EPA designated areas in Indiana under the standards for fine particles on December 17, 2004 as attainment, nonattainment or unclassifiable, with an effective date of April 5, 2005.

Table 1.1
National Ambient Air Quality Standards for Fine Particles

	Annual	24-Hour
1997 Fine Particles Standards ($PM_{2.5}$)	**15 $\mu g/m^3$** Annual arithmetic mean, averaged over 3 years	**65 $\mu g/m^3$** 24-hour average, 98^{th} percentile, averaged over 3 years
2006 Fine Particles Standards ($PM_{2.5}$)	**15 $\mu g/m^3$** Annual arithmetic mean, averaged over 3 years	**35 $\mu g/m^3$** 24-hour average, 98^{th} percentile, averaged over 3 years

Note: The Central Indiana Area meets the 1997 24-hour NAAQS' for fine particles. The 24-hour design value for the area at the close of 2006 was 37.0 $\mu g/m^3$, which is attainment for the 1997 24-hour standard at this time. Since this area is solely designated nonattainment under the 1997 annual standard for fine particles, this document only addresses the annual standard. Designations have not been made for the 2006 revised daily standard at this time.

On December 17, 2004, based on 2001-2003 monitoring data, U.S. EPA designated the Central Indiana Area of Hamilton, Hendricks, Johnson, Marion and Morgan counties as nonattainment of the annual standard for fine particles, and subject to CAA Part D Title 1, Section 172 of Subpart 1 requirements, including the development of a plan to reduce oxides of nitrogen (NO_x), sulfur dioxide (SO_2) and direct $PM_{2.5}$ emissions and a demonstration that the area will meet the annual standard for fine particles by April 5, 2010.

The Central Indiana fine particle nonattainment area as defined in Section 1.3 has not previously been subject to nonattainment area rulemakings for fine particles. However, the area had been subject to nonattainment area rulemakings under the 1-hour and/or the 8-hour ozone standards. Marion County was designated to attainment for the 1-hour ozone standard on November 30, 1994. The 1-hour ozone standard was revoked on June 15, 2005 and Marion County was redesignated to attainment and classified as maintenance under the 8-hour ozone standard on October 19, 2007.

Table 1.2
Central Indiana 2001-2003 Air Quality Monitoring Data used for Designation

SITE ID	COUNTY	SITE NAME	YEAR	Annual Average $\mu g/m^3$	2001-2003 Average $\mu g/m^3$
18-097-0042	Marion	Mann Road	2001	14.78	
18-097-0042	Marion	Mann Road	2002	15.22	
18-097-0042	Marion	Mann Road	2003	14.53	**14.8**
18-097-0078	Marion	Washington Park	2001	16.58	
18-097-0078	Marion	Washington Park	2002	16.55	
18-097-0078	Marion	Washington Park	2003	15.45	**16.2**
18-097-0079	Marion	7250 E 75th Street	2001	16.25	
18-097-0079	Marion	7250 E 75th Street	2002	15.68	
18-097-0079	Marion	7250 E 75th Street	2003	14.67	**15.5**
18-097-0081	Marion	West 18th Street	2001	17.14	
18-097-0081	Marion	West 18th Street	2002	14.24	
18-097-0081	Marion	West 18th Street	2003	16.21	**15.9**
18-097-0083	Marion	2302 E Michigan Street	2001	17.09	
18-097-0083	Marion	2302 E Michigan Street	2002	16.72	
18-097-0083	Marion	2302 E Michigan Street	2003	16.32	**16.7**

These designations became effective on April 5, 2005. Also, on April 5, 2005, U.S. EPA issued a supplemental notice changing the designation status of several areas based on updated quality assured monitoring data from 2002-2004. This action did not affect the Central Indiana area. Monitors for fine particle levels for the Central Indiana area are only located in Marion County (see Figure 1.1). Based on the most recent three years of monitoring data, 2004-2006, the Central Indiana fine particle nonattainment area has not measured air quality that meets the standard. A comprehensive detail of the monitoring data is included in Appendix A.

The Clean Air Act Amendments of 1990 (CAAA) requires areas designated nonattainment for the fine particle NAAQS to develop State Implementation Plans (SIPs) to expeditiously attain and maintain the standard. Section 172 of the CAA stipulates the requirements nonattainment areas must meet, including the development of a plan to reduce direct fine particle emissions and certain precursors for fine particles, nitrogen oxides and sulfur dioxides. The plan must include a demonstration that the area will meet the ambient air quality standard within five (5) years of designation, or April 5, 2010.

In accordance with U.S. EPA's *Clean Air Fine Particle Implementation Rule*[1], this document demonstrates that, with the combination of current clean air measures and the implementation of local and federally-required control measures, air quality in the Central Indiana nonattainment area will meet the annual fine particle standard by the attainment date. This document contains the annual fine particle standard attainment demonstration for the Central Indiana annual fine particle nonattainment area.

1.3 GEOGRAPHICAL DESCRIPTION

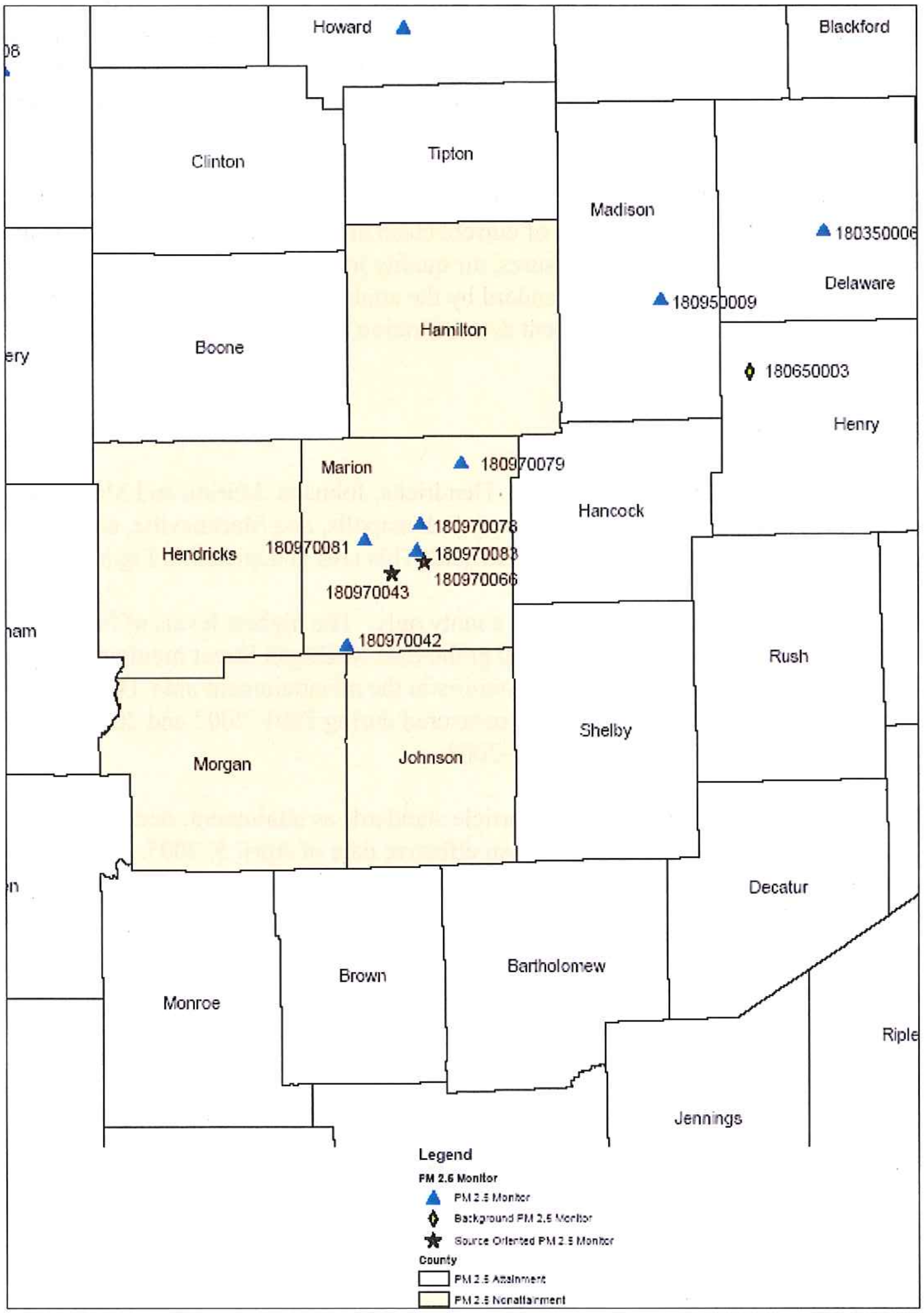
The Central Indiana Area includes Hamilton, Hendricks, Johnson, Marion and Morgan counties and contains such cities as Carmel, Greenwood, Indianapolis, and Martinsville, and such towns as Brownsburg, Fishers, Mooresville and Plainfield. This area is depicted in Figure 1.1.

Fine particle monitors are located in Marion county only. The highest levels of fine particle concentrations have been typically monitored at the East Michigan Street monitor (18-097-0083). Refer to Figure 1.1 for the location of the monitors in the nonattainment area. Designations were made based upon monitored air quality data measured during 2001, 2002 and 2003. Table 1.2 shows the monitored design values for 2001-2003.

U.S. EPA designated areas under the fine particle standards as attainment, nonattainment or unclassifiable, on December 17, 2004, with an effective date of April 5, 2005. The Central Indiana fine particle nonattainment area was designated nonattainment of the annual fine particle standard pursuant to the CAA. As a result, Section 172(c) of the CAA set forth requirements for Indiana's State Implementation Plan (SIP) submittal.

[1] http://www.epa.gov/fedrgstr/EPA-AIR/2007/April/Day-25/a6347.htm

Figure 1.1
U.S. EPA Fine Particle Nonattainment Area Designations



1.4 CONTROL STRATEGY

Several control measures already in place or being implemented over the next few years will reduce stationary point, on-road mobile, and non-road source emissions. The expected Federal and State control measures were modeled for the attainment year of 2009.

The Federal control measures that were modeled included the Tier 2 vehicle standards, the heavy-duty gasoline and diesel highway vehicle standards, low sulfur gasoline and diesel fuels, large non-road diesel engines standards and the non-road spark-ignition engines and recreational engines standard.

The State control measures that were modeled include the NO_x SIP Call and the Clean Air Interstate Rule (CAIR). The control measures included in the modeling are described in greater detail in Section 6.0.

1.5 ATTAINMENT TEST

U.S. EPA guidance requires that attainment demonstrations for fine particles be supported by photochemical grid modeling. A computer model is used to predict maximum fine particle concentrations in every grid cell (or point of analysis) within the nonattainment area.

The attainment test is not based on absolute modeling results, but rather relative responses achieved by comparing the modeled base year to the modeled control strategy, at specific monitoring sites. The benchmark for attainment is that the results of applying the relative response factors to the current monitored design values are below the annual fine particle standard. The latest regional modeling conducted by the Lake Michigan Air Director's Consortium (LADCO) showed all future year concentrations below the annual fine particle NAAQS of 15.0 $\mu g/m^3$.

The results of the various steps used to calculate the predicted future year concentrations for each monitor in the Central Indiana fine particle nonattainment area are shown in Table 1.3. The first three columns are the monitor identification number, monitor name and county in which the monitor is located. The next two columns are the modeling base year design value and the future year design value. As shown in Table 1.3, all of the monitors in the area are expected to be below the standard. According to U.S. EPA guidance, areas with future year design values lower than 14.5 $\mu g/m^3$ at each monitor site need to provide only a basic supplemental analysis that the area will attain the annual fine particle standard. Areas with future year design values between 14.5 $\mu g/m^3$ and 15.5 $\mu g/m^3$ need to provide a more comprehensive weight of evidence analyses to demonstrate that the area will attain the fine particle NAAQS.

Table 1.3
Attainment Test Results

Monitor ID	Monitor Name	County	Design Value 2003-2006	Basecase with CAIR - 2009
			($\mu g/m^3$)	($\mu g/m^3$)
180970042	Mann Road	Marion	14.2	11.7
180970078	Washington Park	Marion	15.2	12.7
180970079	E. 75th St.	Marion	14.7	12.2
180970081	W 18th St	Marion	16.1	13.2
180970083	E. Michigan St.	Marion	15.9	13.2

Since the area's future year design value is predicted to be significantly below the fine particle standard, at 13.2 $\mu g/m^3$, only a basic supplemental analysis is required to support the modeling analysis. This analysis further demonstrates that the nonattainment area will comply with the annual fine particle standard by the prescribed attainment date of April 5, 2010. This demonstration includes an analysis of air quality trends, emission trends, current air quality data, summary of emissions reductions still to occur in 2008 and 2009, along with additional measures that were not included in the air quality modeling. IDEM believes that the modeled attainment demonstration in conjunction with the supplemental analysis, and an identified set of control measures provides the necessary evidence that the Central Indiana nonattainment area will attain the fine particle standard by April 5, 2010.

The structure and content of this document addresses each of the elements required by the CAA and U.S. EPA guidance. Compliance with these elements provides the technical analysis necessary to support a demonstration of the following:

- the Central Indiana area will attain the annual fine particle standard by the attainment date;
- air quality in the area is improving;
- emissions reductions from national and regional control measures included in the attainment plan will bring the area into attainment as expeditiously as possible;
- regional modeling performed by the Midwest Regional Planning Organization demonstrates that with regional NO_x reductions the area will be able to comply with the annual fine particle standard without additional control measures; and
- the additional implementation of control measures not included in the modeling analysis will provide further assurance that the standard is attained and maintained.

2.0 CLEAN AIR ACT REQUIREMENTS

Section 172(c) of the CAA specifies the various planning requirements that apply to fine particle nonattainment areas. The CAA specifies the following requirements:

1. General requirements for Reasonably Available Control Measures (RACM)/Reasonably Available Control Technology (RACT),
2. Reasonable Further Progress (RFP),
3. Emission inventories,
4. Identification and quantification of emissions,
5. Permit program for new and modified sources,
6. Other control measures, means or techniques
7. Compliance with section 110(a)(2),
8. Equivalent techniques,
9. Contingency measures

These components are due April 5, 2008. The following section provides an overview of Indiana's progress in meeting the CAA requirements mentioned above.

2.1 GENERAL REQUIREMENTS (SECTION 172(C)(1))

2.1.1 Reasonably Available Control Measures (RACM)

The CAA requires a demonstration that the State has adopted all reasonable and available control measures to demonstrate attainment as expeditiously as practicable and that no additional measures that are reasonably available will advance the attainment date. Although regional photochemical modeling indicates that no additional control measures are necessary to achieve the annual fine particle standard by the attainment date, IDEM participates in the regional planning effort through the Midwest Regional Planning Organization (MRPO) to evaluate potential control measures to attain the 8-hour ozone and fine particle standards and achieve regional haze goals.

Candidate control measures were evaluated primarily for feasibility, cost effectiveness, and the ability to implement them in a relatively short time frame (i.e., January 1, 2009, for the 2009 monitoring year). Due mainly to the lengthy rulemaking process in Indiana, many of the control strategies evaluated could not be implemented by the 2009 monitoring year and were not pursued since they were not needed to demonstrate attainment in an expeditious fashion.

2.1.2 Reasonably Available Control Technology (RACT)

U.S. EPA's *Clean Air Fine Particle Implementation Rule* makes a determination that areas classified under Subpart 1 will meet the CAA's RACT requirement by submitting a demonstration that shows attainment as expeditiously as practicable, but no later than 5 years after designation. This document will show that this requirement will be met with the implementation of mandatory federal control measures and regional measures implemented in

Indiana. This document also shows that the projected annual fine particle design value will provide an ample margin of safety, well below U.S. EPA's defined threshold for a detailed RACT analysis to be completed in conjunction with this submittal.

2.2 REASONABLE FURTHER PROGRESS (SECTION 172 (C)(2))

Based on U.S. EPA's Fine Particle Implementation rule, Reasonable Further Progress (RFP) is met by ensuring emissions reductions needed for attainment are implemented by the beginning of the monitoring season preceding the attainment date (i.e., by January 1, 2009). As confirmed by regional photochemical modeling, no additional local controls are necessary to attain the air quality standard expeditiously by the attainment date.

2.3 EMISSION INVENTORIES (SECTION 172 (C)(3))

U.S. EPA guidance requires the submittal of a comprehensive emissions inventory of direct fine particle and fine particle precursor emissions (oxides of nitrogen (NO_x) and sulfur dioxide (SO_2) representative of the base year (2005), and a projection of the emission inventory to the attainment year (2009). Consistent with the federal implementation rule for fine particles, Indiana does not consider volatile organic compounds or ammonia to be significant contributors to fine particles. IDEM meets this requirement through the submittal statewide emissions inventory under the Consolidated Emission Reporting Rule (CERR) for the State of Indiana.

IDEM submitted a statewide 2005 emissions inventory for stationary and area sources to U.S. EPA in June 2007. The 2005 emission inventory, for the Central Indiana area, is included as Appendix B. The emission inventories used in this attainment demonstration are also subject to public comment along with the full attainment demonstration.

2.4 IDENTIFICATION AND QUANTIFICATION OF EMISSIONS (SECTION 172 (C)(4))

Section 172(c)(4) requires the SIP to identify and quantify the emissions of pollutants (in this case, particulate matter, NO_x and SO_2) that sources will be allowed from the construction and operation of major new and modified sources in accordance with section 173(a)(1)(B), and will not interfere with attainment of the annual fine particle standard by the attainment date. Indiana's permitting rules which meet this requirement are outlined in rule 326 IAC 2-3.

2.5 PERMIT PROGRAM FOR NEW AND MODIFIED MAJOR SOURCES (SECTION 172 (C)(5))

Section 172 (c)(5) requires the State to implement a permit program consistent with the requirements of Section 173. Indiana has a long standing and fully-implemented New Source Review (NSR) permitting program that is outlined in rule 326 IAC 2-3. Indiana's NSR program was approved by U.S. EPA, on October 7, 1994 (94 FR 24838), as part of the SIP.

Any facility that is not listed in the 2005 emission inventory, or for the closing of which credit was taken in demonstrating attainment, will not be allowed to construct, reopen, modify, or reconstruct without meeting all applicable permit rule requirements, including an air quality analysis to evaluate whether the new source will threaten the NAAQS.

2.6 OTHER CONTROL MEASURES, MEANS OR TECHNIQUES (SECTION 172 (C)(6))

Modeling conducted by the Lake Michigan Air Director's Consortium (LADCO) for future year fine particle design values show that existing emission control measures will bring the Central Indiana area into attainment of the annual fine particle NAAQS and provide for an ample margin of safety. Federal and local control measures to be phased-in or implemented in the next several years will provide even greater assurance that air quality will continue to meet the standard into the future.

In addition, modeling conducted by LADCO to determine the impact of the Clean Air Interstate Rule in the region, show that future year design values for the Central Indiana fine particle nonattainment area will attain the annual fine particle standard with values well below 15.0 $\mu g/m^3$.

Existing and future national and regional control measures will ensure that attainment in each county will be maintained with an increasing margin of safety over time. These measures are discussed in greater detail in the Control Strategy Section (Section 6.0).

Therefore, no additional control measures are being implemented and modeled to demonstrate attainment. However, additional control measures are being implemented region-wide to provide assurance of the area maintaining air quality below the standard.

2.7 COMPLIANCE WITH SECTION 110(A)(2) (SECTION 172 (C)(7))

Section 172(c)(7) requires nonattainment SIPs to meet the applicable provisions of Section 110(a)(2). IDEM has reviewed the requirements of Section 110(a)(2) and has concluded that prior rule submittals, along with this attainment demonstration, address the relevant requirements associated with rule development, state implementation plan submissions, and implementation and enforcement of required control measures. Within a letter to U.S. EPA dated December 7, 2007, Indiana reaffirmed that it maintains the necessary infrastructure and resources to comply with Section 110(a)(1) and (2) for all criteria pollutants (Appendix C).

2.8 EQUIVALENT TECHNIQUES (SECTION 172(C)(8))

IDEM has followed U.S. EPA guidance on procedures for modeling, preparing emission inventories and plan submitted. Therefore, IDEM is not requesting approval for equivalent techniques, as allowed under Section 172(c)(8).

2.9 CONTINGENCY MEASURES (SECTION 172 (C)(9))

Section 172 (c)(9) of the CAA requires States with nonattainment areas to include contingency measures as part of their attainment demonstration. Contingency measures are specific measures to be undertaken in the event that the area fails to attain the standard by the applicable attainment date. The selected contingency measures are discussed in greater detail in Section 9.0 of this document.

2.10 ATTAINMENT DEMONSTRATION

U.S. EPA's fine particle implementation rule requires the submittal of an attainment demonstration SIP that includes local, regional and/or national modeling analyses that meet the attainment modeling criteria set forth in U.S. EPA's modeling guidance. Through the Midwest Regional Planning Organization (MRPO), LADCO performed photochemical modeling using the Comprehensive Air Quality Model with Extensions (CAMx) for this modeled attainment demonstration. This modeling is being supplemented with regional modeling performed by LADCO in developing the Clean Air Interstate Rule (CAIR) and rulemaking to support national control measures.

U.S. EPA modeling guidance for the annual fine particle standard stipulates that the following elements be included in an approvable attainment demonstration submittal:

- photochemical grid modeling analysis;
- air quality trends analysis;
- emissions trends analysis;
- identification of control measures factored into the modeling analysis as well as those not factored into the modeling analysis; and
- identification of mobile source emission budgets (SO_2, NO_x and direct $PM_{2.5}$) for transportation conformity purposes.

Each element of the Attainment Demonstration is described briefly below and in more detail in the Technical Elements of Demonstration (Sections 3.0 – 7.0) and Mobile Source Emission Budgets (Section 8.0).

2.10.1 Photochemical grid modeling analysis

A more detailed discussion of the photochemical grid modeling, model selection, methodologies, attainment test, model inputs, modeling protocol and analysis method is included in the Photochemical Modeling Analysis Section of the Technical Element of Demonstration (Section 3.1).

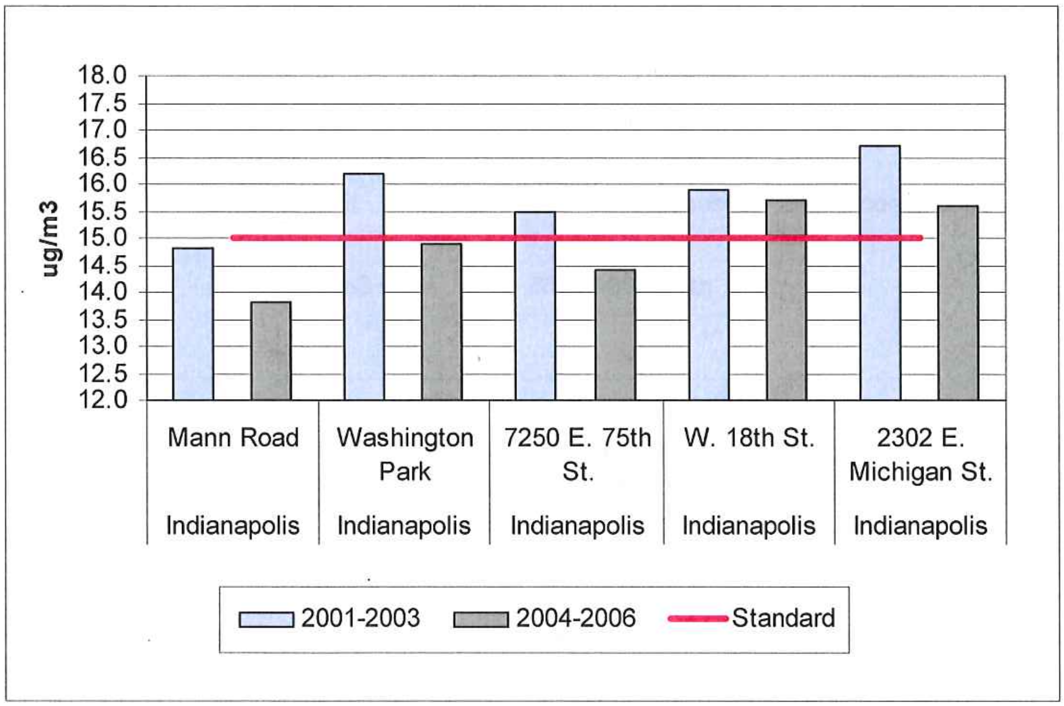
2.10.2 Air Quality Trends Analysis

Implementation of control strategies has resulted in significant improvement in air quality in the Central Indiana annual fine particle nonattainment area. Data show emissions are decreasing, air quality peak values are on the decline, and the number of exceedances is also decreasing.

The technical data, (Sections 3.0-7.0) show a continual decline in the fine particle concentration levels since 2001.

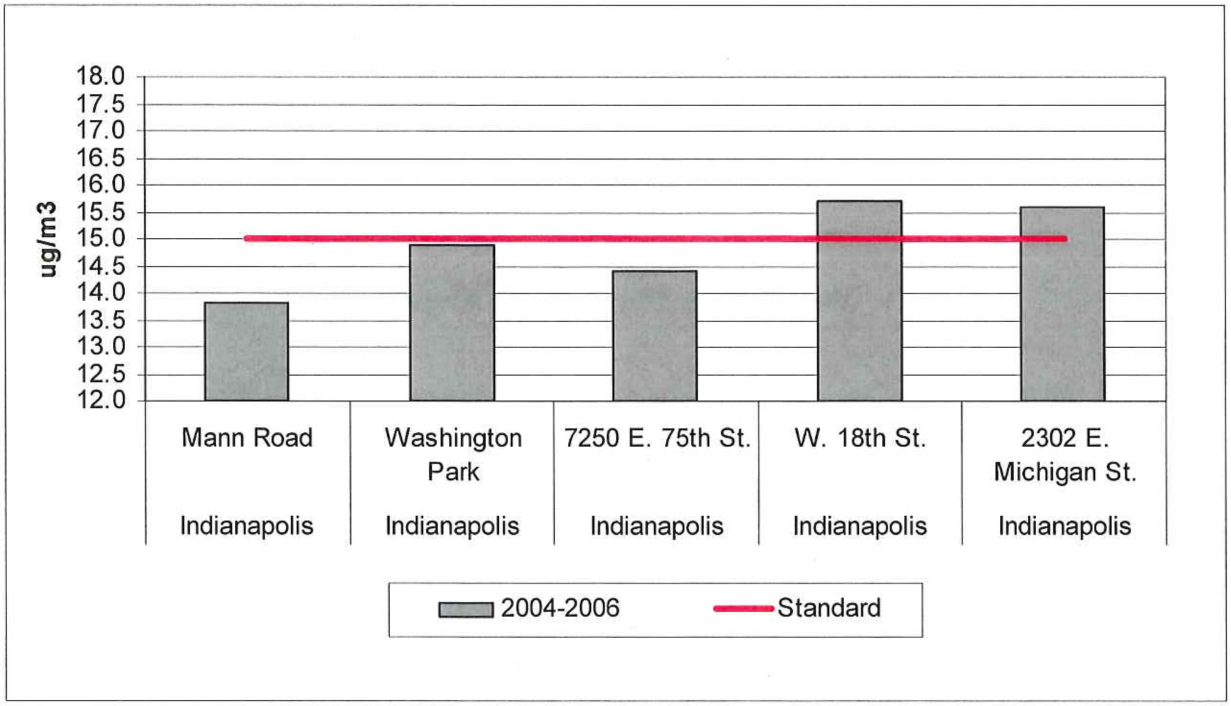
Chart 2.1 shows the decline in the controlling fine particle design value[2] for the Central Indiana fine particle nonattainment area. During the 2001-2003 time period, the East Michigan Street ambient monitor represented the area' s controlling annual fine particle design value. As shown in this table, the area' s design value has decreased from 16.7 $\mu g/m^3$ to 15.6 $\mu g/m^3$, a decline of 1.1 $\mu g/m^3$ since being designated as nonattainment. The current design value for 2004-2006 is shown in Chart 2.2. Modeling predicts that this value will decline by an additional 2.4 $\mu g/m^3$ by 2009, demonstrating attainment of the standard prior to the April 5, 2010 attainment date.

Chart 2.1
Fine Particle Design Value Trends



[2] The design value for a nonattainment area, which characterizes the severity of the area's air quality problem, is represented by the highest design value at any individual fine particle monitoring site. The design value of a monitoring site is the average of the fine particle value over a three-year period. If a monitor is less than or equal to 15.0 $\mu g/m^3$ it is considered attainment. A monitor that measures 15.05 $\mu g/m^3$ or higher is considered nonattainment. (Decimals 0.049 or lower are rounded down, decimals 0.050 are rounded up). Three year design values are reported with only 1 decimal point. Values close to 15.0 $\mu g/m^3$ may be shown with two decimal points for clarification.

Chart 2.2
Fine Particle Design Values for the Central Indiana Nonattainment Area



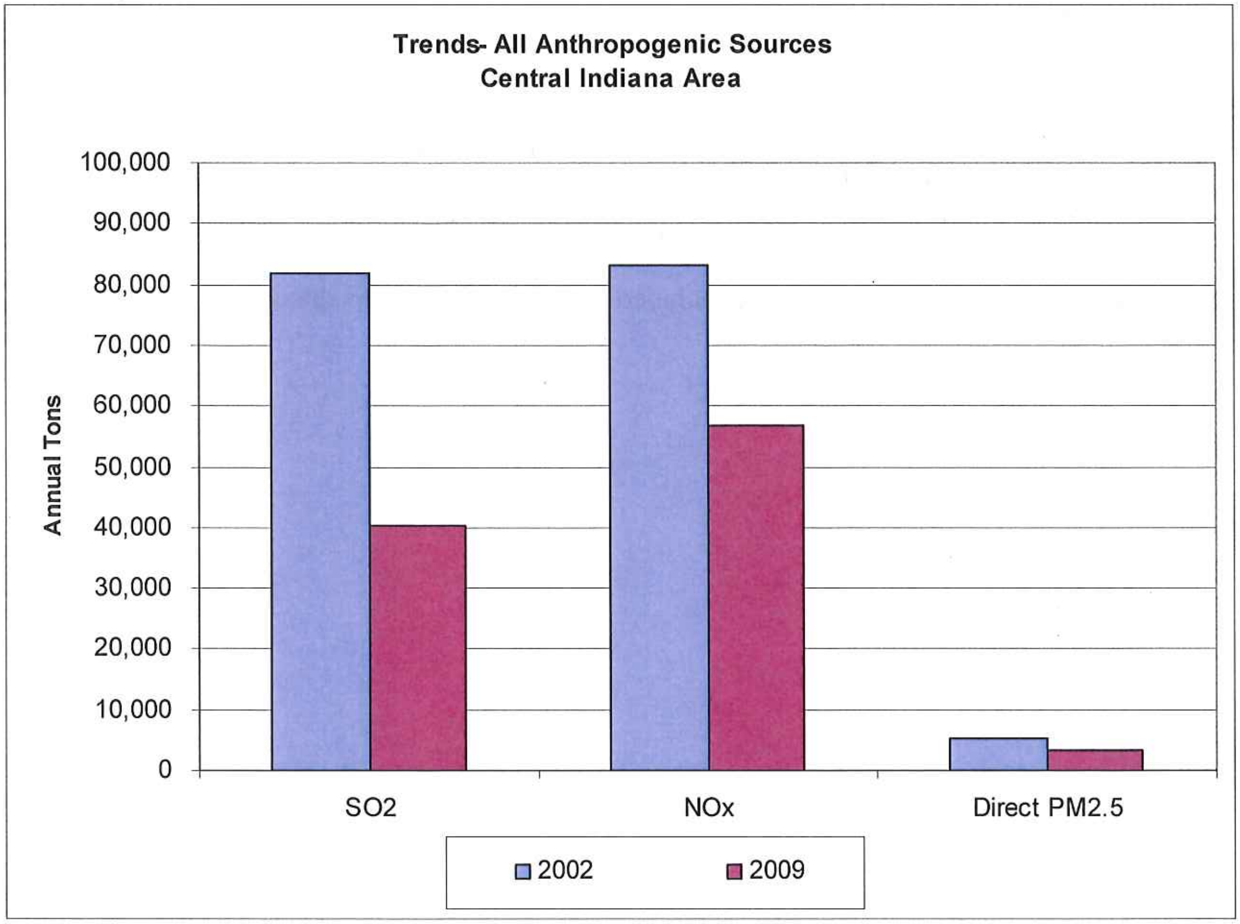
A more complete picture of the air quality improvement in the Central Indiana fine particle nonattainment area is shown Chart 4.1 and Figure 4.3, included in Section 4.0 of this document.

2.10.3 Emissions Trends Analysis

Control measures have been implemented requiring substantial emissions reductions from mobile, industrial, and area sources. As shown in Chart 2.3, a comparison of actual 2002 and 2009 projected NO_x emissions for the nonattainment area show an overall regional reduction of approximately 32%. A similar comparison for $PM_{2.5}$ and SO_2 emissions shows an overall regional reduction of 37 % and 51% over the same time period. The emissions from the overall inventory are projected to decrease further by the 2010 attainment date.

A more detailed discussion of emission trends is included in the Emissions Trends Analysis section of this document (Section 5.0).

Chart 2.3
Emissions Trends 2002-2009



2.11 CONTROL STRATEGY

Several control measures already in place or being implemented over the next few years will reduce point, on-road mobile and non-road mobile source emissions. The Federal and State control measures included in the photochemical modeling for the future year design value and additional control measures due to be implemented, but were not included in the modeling are discussed in greater detail in the Technical Support Document (Section 6.0).

2.12 MOBILE SOURCE EMISSIONS BUDGETS

U.S. EPA requirements outlined in 40 CFR 93.118(e) (4) stipulate that a mobile source emissions budget be established as part of the attainment demonstration. The mobile source emissions budget is necessary to demonstrate conformity of transportation plans with the state implementation plan.

The purpose of transportation conformity is to ensure that Federal transportation actions occurring in the nonattainment area do not hinder the area from attaining and maintaining the annual fine particle standard. This means that the level of emissions estimated by the metropolitan planning organization for the Transportation Implementation Plan (TIP) and the Long Range Transportation Plan must not exceed the motor vehicle emission budgets as defined in this attainment demonstration.

In general, while the total vehicle miles traveled (VMT) has increased throughout the region, mobile source emission levels have decreased significantly since 1999. This decline in emissions is a result of federal motor vehicle control requirements and cleaner motor fuels.

The motor vehicle emission budgets are included in Section 8.0 of this document.

3.0 TECHNICAL ELEMENTS OF DEMONSTRATION

This section presents details of the technical work done to analyze air quality data to demonstrate attainment of the annual fine particle standard. The results of the computer modeling and an analysis of air quality and emissions inventory trends presents strong evidence that pending control measures will improve air quality, thereby assuring air quality levels below the annual fine particle NAAQS by April 5, 2010.

3.1 PHOTOCHEMICAL MODELING ANALYSIS

Indiana is required to submit modeling as part of its attainment demonstration. U.S. EPA's implementation guidance allows states to submit regional or national modeling as the sole (primary) modeling analysis. This modeling demonstration relies upon regional modeling as the primary modeling analysis and Indiana will include national modeling, conducted by U.S. EPA as supplemental analysis.

The primary attainment modeling analysis for the Central Indiana nonattainment area was performed in conjunction with the fine particle ($PM_{2.5}$) and regional haze modeling conducted by the Midwest Regional Planning Organization (MRPO). The MRPO is made up of five Midwest states (Illinois, Indiana, Michigan, Ohio and Wisconsin) and the Lake Michigan Air Directors Consortium (LADCO). LADCO provides expertise in review of monitoring data, development of emissions inventories and meteorological files and application of photochemical modeling and evaluation of model performance and modeled results. LADCO prepared the "Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze: Technical Support Document" (LADCO, 2008), a detailed technical support document describing the methodology for the fine particle attainment demonstration modeling analysis for all the states in the MRPO. This document can be found in Appendix E.

Extensive regional modeling has been performed covering the Central Indiana area to determine the effect of national, regional and local emission control strategies on fine particle levels. These modeling analyses determined that Central Indiana, including Marion, Hamilton, Hendricks, Morgan and Johnson counties, is impacted by regional transport of fine particles and its precursors; sulfur dioxide (SO_2), nitrogen oxides (NO_x), organic carbon (OC) and ammonium (NH_4) associated with sulfates and nitrates. National emissions reductions, including those associated with the Clean Air Interstate Rule (CAIR) are an effective way to demonstrate attainment of the annual fine particle standard in this area. Future year modeled annual fine particle concentrations in Central Indiana are expected to be reduced from baseline design values by 16% to 18% in 2009 and reduced by 22% to 23% by 2018 leading to the attainment of the annual fine particle NAAQS of 15 micrograms per cubic meters ($\mu g/m^3$).

The following paragraphs briefly describe the methods, inputs used and major components of this analysis. The attainment demonstration and modeling procedures followed were recommended by U.S. EPA's "Guidance on the Use of Models and Other Analyses for Demonstration Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze" (EPA-454/B-07-002, April 2007), Appendix D.

3.1.1 Modeling Methodology

The modeling analysis is a complex technical evaluation that begins with selection of the modeling system. The MRPO used the following modeling system:

- Air Quality Model: Comprehensive Air Quality Model with Extensions (CAMx version 4.50).
- Meteorological Model: Mesoscale Model (MM5) version 3.7.
- Emissions Models: Emissions Modeling System (EMS-2003) and CONsolidated Community Emissions Processing Tool (CONCEPT).

Model Selection

Title 40 Code of Federal Regulations, Part 51, Appendix W does not offer specific recommendations for photochemical models to be used for attainment demonstrations. However, the models selected must be scientifically appropriate for the intended application and be freely available for review and available to stakeholders and their consultants for execution and verification at low or no cost. Each of the models selected for use in this analysis meet these criteria and has been peer reviewed. Past performance has shown that the models are not biased toward under or overestimates.

The air quality model selected for this technical analysis was CAMx (version 4.50), an Eulerian photochemical grid model developed by ENVIRON and approved by U.S. EPA for this use. CAMx allows for integrated "one-atmosphere" assessment of ozone and $PM_{2.5}$. More notable features of CAMx include flexi-nesting, which allows for reconfiguration of nested grids within the model, multiple gas phase chemistry mechanism options and Particulate Source Apportionment Technology. CAMx modeling is performed on a Linux computing platform with a Portland Group (PGI) Fortran compiler to create executable files.

3.1.2 Modeling Preparation and Objectives

The modeling analysis included (1) preparation of a protocol; (2) preparation of emission inventories; (3) preparation of meteorological inputs; (4) application of the model and diagnostic analysis of inputs; (5) evaluation of performance; (6) evaluation of reduction scenarios and (7) analysis of modeling results. The specific objectives of the analysis were to:

* apply the model to 2005 meteorological and emissions data and evaluate CAMx model performance;
* prepare future-year (2009) emissions inventory to evaluate future federal, regional and local emission control strategies for the attainment of federal fine particle standards; and
* run the model for the future year to evaluate the combined effects of growth and emission reductions resulting from national, regional and local measures.

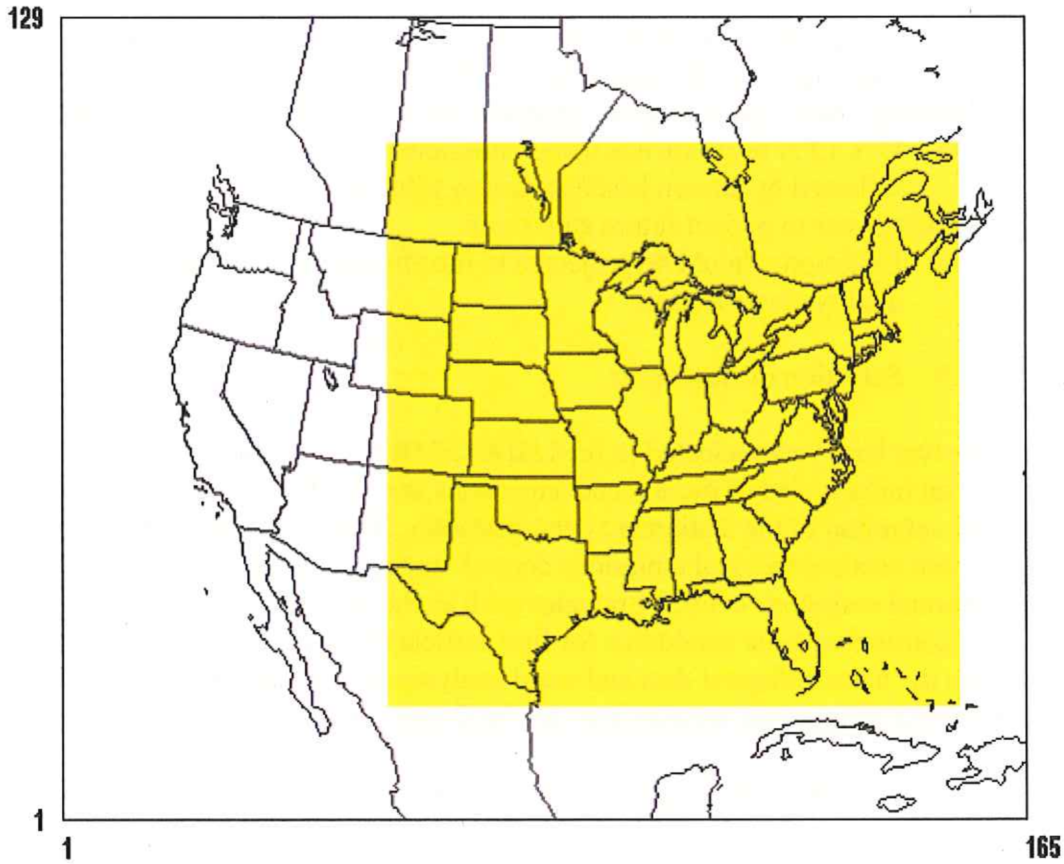
3.1.3 Meteorology Selection

Domain and grid resolution for the modeling analyses included a national RPO grid at 36 kilometers for both the meteorological and emissions modeling. Landuse files were based on the Biogenic Emissions Landuse Database, version 3 (BELD3) 1 kilometer data and photolysis rates were calculated with the Tropospheric Ultraviolet-Visible (TUV) radiation model.

3.1.4 Modeling Domain

The domain for this modeling analysis was approximately centered on the Midwest portion of the country, including the Central Indiana nonattainment area. The meteorological modeling domain consisted of a 36 kilometer grid that extended over the entire continental United States. The photochemical modeling grid consisted of a 36 kilometer grid over the MRPO 5-state region and adjacent states. Selection of the domain was based upon distribution of emission sources, locations of meteorological and air quality monitoring sites, and typical meteorological conditions in the area. Figure 3.1 shows the meteorological and emissions modeling domain.

Figure 3.1
MRPO Modeling Domain



Meteorological inputs were processed using the National Center for Atmospheric Research (NCAR) 5th generation Mesoscale Model (MM5) version 3.7. A more detailed explanation of the inputs for the MM5 model are listed on page 46 of the "Regional Air Quality Analyses for Ozone, $PM_{2.5}$, and Regional Haze Technical Support Document", included in Appendix E.

The modeling analysis involves several steps. Below is a brief overview of the steps involved. A more detailed explanation of the modeling analysis and methodology can be found in Appendix F of this document.

Modeled Attainment Demonstration for Annual $PM_{2.5}$

1) Calculate site-specific baseline concentrations.
   a. Annual arithmetic mean is calculated by averaging the four quarterly arithmetic mean concentrations observed during a calendar year
2) Identifying grid cells near monitoring site.
   a. U.S. EPA recommends using the single modeled value in or near the grid cell which contains the monitor
3) Choosing model predictions to calculate a relative response factor (RRF) near a monitor.
   a. For an annual $PM_{2.5}$ prediction, U.S. EPA recommends taking the spatially averaged values of the nearby predictions (mean value of the grid cell array)
   b. The component-specific RRFs are computed by taking the ratio of the mean of the spatially averaged daily predictions
4) Estimating design values at unmonitored locations.
   a. Interpolate ambient data by creating a set of quarterly average spatial fields
   b. The 4 quarters can then be averaged to get an annual average set of fields
5) Choosing a base year emissions inventory to be projected for calculating RRFs.
   a. U.S. EPA recommends using emissions which correspond to the modeled period reflected by chosen baseline design value period
6) Choosing year to project future emissions.
   a. Emissions should be projected to the attainment year, based on an area's air quality classification

3.1.5 Selection of Base Year

There were two base years selected in the LADCO/MRPO modeling analyses: 2002[3] and 2005. 2002 was run initially and as more recent emissions and meteorological data became available prior to the submittal of the attainment demonstration, 2005 was evaluated. The emissions for 2005 take into account national emissions control strategies as opposed to 2002 which did not include national emissions control strategies such as the NO_x SIP Call. 2005 had meteorological conditions considered to be conducive for fine particle development. LADCO performed several analyses on the meteorological data and trend analyses on fine particles and its pre-cursors. Results showed comparable meteorology for 2002 and 2005 and Theil trend analysis showed

[3] U.S. EPA guidance recommended using 2002 as the baseyear for modeling analyses, but allows states to use 2005. LADCO began the modeling exercise using 2002 as the baseyear, but as more recent emissions and meteorological data became available prior to the modeling being completed; a decision was made to switch to 2005 as the baseyear. This decision was discussed with U.S. EPA staff.

consistent improvement of fine particle concentrations throughout the Midwest since 1999 with annual decreases from 0.2 to 0.5 $\mu g/m^3$ in the Central Indiana area.

3.1.6 Selection of Future Years

The future year of interest for Central Indiana, due to its annual $PM_{2.5}$ nonattainment status, was 2010 (five years from the effective date of designation under the annual standard). This year represents the attainment date. Therefore, 2009 is the future year of interest in order to show emission reductions preceding the attainment year. 2012 and 2018 future years were also modeled in order to demonstrate continued attainment of the fine particle NAAQS.

3.1.7 Emissions Inputs

Emissions Model System (EMS) and CONCEPT are two of the key emissions modeling tools used to determine emission estimates for LADCO's Round 5 photochemical modeling.

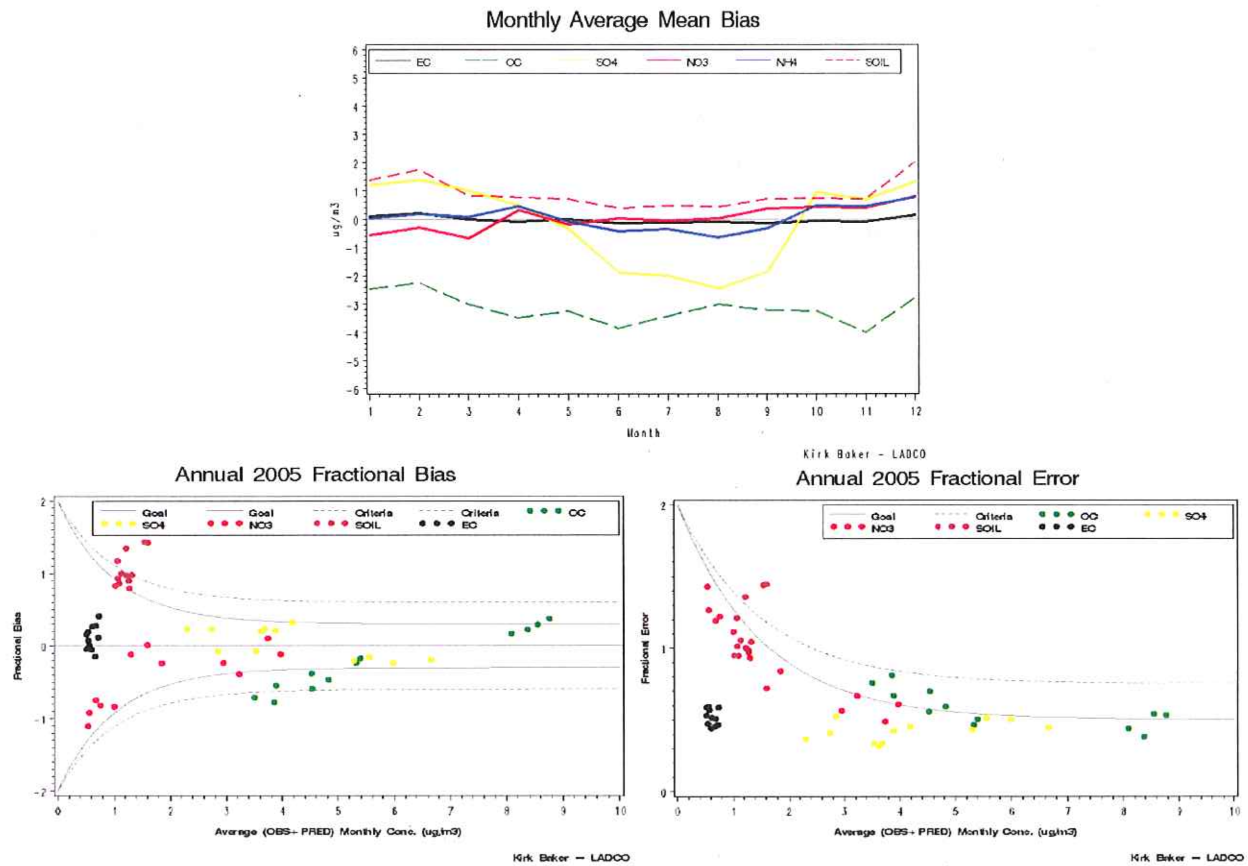
- Onroad source emissions were developed from CONCEPT using vehicle miles traveled (VMT) and vehicle speed supplied by state and local planning agencies for 24 networks. The CONCEPT model was run for winter (January 15-17) and summer (July 16-18) emission profile days representing a weekday, Saturday and Sunday.
- Nonroad source emissions were developed from the National Mobile Inventory Model (NMIM2005). Marine, aircraft and railroad emissions were prepared by ENVIRON, 2007 and handled separately from nonroad sources.
- Area source emissions were developed with the Emissions Modeling System (EMS) for weekday, Saturday and Sunday emissions for each month of the modeled period.
- Point source emissions were developed from state inventories and continuous emissions monitoring (CEM) data from electrical generating units. The Emissions Modeling System (EMS) calculated the point source emissions for weekday, Saturday and Sunday emissions for each month of the modeled period.
- Biogenic emissions were supplied by Alpine using an updated CONCEPT/MEGAN biogenic emissions model.
- Ammonium emissions were developed from a Carnegie Mellon University based 2002 ammonia emissions model which were grown out to 2005 and adjusted by temporal monthly factors.
- Canadian emissions were taken from the 2005 Canadian National Pollutant Release Inventory, Version 1.0 (NPRI).

Future year emissions were grown from the basecase 2005 emissions and estimates were developed from the emissions models; EMS/CONCEPT and NMIM for on-road and non-road emission sources. Future year emissions for EGUs were derived from Integrated Planning Model version 3.0 (IPM3.0) with several Clean Air Interstate Rule (CAIR) emission control scenarios factored in. Growth and control factors were applied to area, marine/aircraft/ railroad and non-EGU point source emissions as well as emission changes due to applied local consent decrees, Reasonably Achievable Control Technologies (RACT) and Best Achievable Retrofit Technology (BART).

3.1.8 Model Performance

Model performance was evaluated according to U.S. EPA statistical guideline recommendations, in order for the modeled concentrations to replicate observed concentrations. $PM_{2.5}$ model performance was evaluated by LADCO through a variety of methods. Time series plots of monthly average mean bias and annual fractional bias were used and are shown in Figure 3.2.

Figure 3.2
Model Performance Metrices for Annual $PM_{2.5}$ Modeling



Model performance was relatively good for nitrates, elemental carbon, ammonium and soil with under prediction of organic carbon and over prediction of sulfates, although the sulfate performance would be considered acceptable with bias values within 35%. The day-to-day as well as the hour-to-hour variations from observed data and modeled data are consistent. There is acceptable modeled performance in the overall fine particle mass concentrations with some variability in the modeled performance of several of the species composition of the fine particles.

3.2 MODELED ATTAINMENT TEST

The modeled attainment demonstration consists of analyses that estimate whether existing and future emission reductions along with appropriate growth factors for future emissions will result in future ambient concentrations that will meet the NAAQS. The attainment demonstration also identifies a set of emission control measures that will ensure that an area will continue to attain the NAAQS into the future. In order to make this determination, a modeled attainment test is required.

The annual $PM_{2.5}$ attainment test, as described in U.S. EPA guidance, recommends a modeled attainment test in which the results are used in a "relative' rather than "absolute" sense. This approach takes the ratio of the photochemical modeling results and future to baseline predictions at specific monitoring sites. This ratio is known as a relative response factor (RRF). Once a RRF has been determined, the RRF is applied to the current design value of a pollutant or in the case of $PM_{2.5}$, the different components which make up fine particles. The major components that make up fine particles are as follows:

- mass associated with sulfates (SO_4);
- mass associated with nitrates (NO_3);
- mass associated with ammonium (NH_4);
- mass associated with organic carbon (OC);
- mass associated with elemental carbon (EC);
- mass associated with particle bound water (pbw);
- mass associated with "other" primary inorganic particulate matter (soil); and,
- passively collected mass.

The steps involved in the annual $PM_{2.5}$ modeled attainment test, otherwise known as the Speciated Modeled Attainment Test (SMAT) are listed below. The specific inputs and results of the SMAT for Central Indiana are listed in Section 3.3 of this document.

Step 1: Compute the observed quarterly mean $PM_{2.5}$ and quarterly mean composition of each monitor.

- This is accomplished by multiplying the monitored quarterly mean concentration of Federal Reference Method (FRM) derived $PM_{2.5}$ by the monitored fractional composition of $PM_{2.5}$ species for each quarter.
- In the event that monitored speciated data is not available, LADCO used chemically speciated IMPROVE and STN $PM_{2.5}$ data to develop seasonal spatial fields for each $PM_{2.5}$ species. SAS software package PROC KRIG function (EPA, 2004b) was used to develop these spatial fields.

Step 2: Using model results, derive component-specific relative response factors (RRF) at each monitor for each quarter for each of the components for $PM_{2.5}$.

- Air quality modeling is applied to estimate current and future year concentrations for each component of $PM_{2.5}$.

- Relative response factors are derived by taking the ratio of future year concentrations over the baseline modeled concentrations at the monitoring site.

Step 3: Apply the component specific relative response factors to the observed air quality to obtain quarterly species estimates.

- The current quarterly mean component concentration from step 1 is multiplied by the component-specific RRF derived in step 2, which gives an estimated future quarterly mean concentration for each component.

Step 4: Calculate a future year annual average $PM_{2.5}$ estimate

- The quarterly mean components (estimated in step 3) are summed together for a quarterly mean $PM_{2.5}$ value.
- The four quarterly mean $PM_{2.5}$ values are determined and the average of these four quarterly mean $PM_{2.5}$ values will give a future year annual average $PM_{2.5}$ value for each monitor analyzed.

3.3 ATTAINMENT TEST RESULTS

LADCO performed the attainment test for all MRPO state monitoring sites, including those located in Central Indiana. LADCO followed U.S. EPA guidance concerning the modeled attainment test for Central Indiana. LADCO's latest modeling (Round 5) showed all future year concentrations were below the annual fine particle NAAQS of 15.0 micrograms per cubic meter. Results of step 1 of the attainment test for annual fine particle NAAQS are shown in Table 3.1, which shows the observed quarterly mean and in Table 3.2, showing the quarterly mean composition of each component of fine particles. This is the observed quarterly mean and composition of the controlling monitor for the Central Indiana area, which is the West 18th St. monitor.

Table 3.1
Observed Quarterly Mean $PM_{2.5}$ /Quarterly Mean Composition
West 18^{th} St. Monitor

Pollutant	Quarter 1	Quarter 2	Quarter 3	Quarter 4
SO4	0.2358	0.3745	0.3582	0.2751
NO3	0.2729	0.0167	0	0.149
OC	0.1851	0.2034	0.1231	0.223
EC	0.0385	0.0447	0.03	0.0525
Soil	0.0239	0.0376	0.0253	0.0358
NH4	0.1561	0.1313	0.1114	0.1378
pbw	0.0877	0.1309	0.1163	0.0865
Quarterly FRM Mean	15.77	14.17	19.73	13.73

Table 3.2
Quarterly Mean Composition for each Component of $PM_{2.5}$
West 18th St. Monitor

Pollutant	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Average
SO_4	3.7186	5.3067	7.0673	3.7771	5.0
NO_3	4.3036	0.2366	0.0000	2.0458	1.6
OC	2.9190	2.8822	2.4288	3.0618	2.8
EC	0.6071	0.6334	0.5919	0.7208	0.6
Soil	0.3769	0.5328	0.4992	0.4915	0.5
NH_4	2.4617	1.8605	2.1979	1.8920	2.1
pbw	1.3830	1.8549	2.2946	1.1876	1.7

Once the observed quarterly mean and composition of the fine particle concentrations are determined, step 2 of the attainment test requires that the component-specific relative response factors be derived for each quarter from the basecase and future year modeled concentrations at each monitor. The results of this step are shown in Table 3.3.

Table 3.3
Relative Response Factors (RRFs) for each Component
West 18th St. Monitor

Pollutant	Quarter 1	Quarter 2	Quarter 3	Quarter 4
SO_4	0.9192	0.6868	0.6529	0.8538
NO_3	0.9769	0.8082	0.8099	0.9452
OC	0.9546	0.9881	1.0043	0.9648
EC	0.8647	0.8547	0.8444	0.8412
Soil	1.0835	1.0625	1.0918	1.0890
NH_4	0.9446	0.7182	0.6854	0.8905
pbw	0.9440	0.7056	0.6674	0.8888

The derived relative response factors for each quarter are then applied to the observed quarterly mean and composition of the fine particle concentrations to calculate the projected quarterly species estimates for each monitor, as per step 3 of the attainment test guidance. Results are shown in Table 3.4.

Table 3.4
Projected Quarterly Species Estimates
West 18th St. Monitor

Pollutant	Quarter 1	Quarter 2	Quarter 3	Quarter 4	TOTAL
SO_4	3.4181	3.6446	4.6142	3.2249	3.7
NO_3	4.2042	0.1913	0.0000	1.9337	1.6
OC	2.7865	2.8479	2.4392	2.9540	2.8
EC	0.5250	0.5414	0.4998	0.6064	0.5
Soil	0.4084	0.5661	0.5450	0.5353	0.5
NH_4	2.3253	1.3362	1.5065	1.6848	1.7
pbw	1.3056	1.3088	1.5314	1.0556	1.3
TOTAL	14.9731	10.4362	11.1361	11.9946	

Step 4 of the attainment test calculates the future year annual average fine particle concentrations, which are compared to the annual fine particle NAAQS of 15.0 micrograms per cubic meter. Table 3.5 shows a summary of the future year – 2009 modeled concentrations that show all fine particle monitors in Central Indiana will attain the annual fine particle standard.

Table 3.5
Attainment Test Results for Central Indiana

Monitor ID	Monitor Name	County	Modeled Design Value 2003-2006	Basecase with CAIR - 2009
			($\mu g/m^3$)	($\mu g/m^3$)
180970042	Mann Road	Marion	14.2	11.7
180970078	Washington Park	Marion	15.2	12.7
180970079	E. 75th St.	Marion	14.7	12.2
180970081	W 18th St	Marion	16.1	13.2
180970083	E. Michigan St.	Marion	15.9	13.2

Results for all the Central Indiana fine particle monitors can be found in Appendix G. Each step of the attainment test is listed for the Mann Road (ID 180970042), Washington Park (ID 180970078), East 75th Street (ID 180970079) and East Michigan Street (ID 180970083) fine particle monitors. Modeled results show similar mean specie compositions and relative response factors at all the fine particle monitoring sites and all monitors show compliance with the annual fine particle NAAQS.

3.4 UNMONITORED AREA ANALYSIS

U.S. EPA has recommended, in its "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze" (EPA-454/B-07-002, April 2007), an "unmonitored area analysis" for areas without monitors that could potentially exceed the NAAQS if monitors existed in those areas. The "unmonitored area analysis" uses a combination of ambient data to provide spatial fields for monitored and unmonitored areas and model output for predicted concentrations throughout a region. Hamilton, Hendricks, Johnson and Morgan counties were designated as nonattainment for the annual fine particle standard despite the fact that there are no fine particle monitors in those counties. These four counties are adjacent to Marion County, which has monitors in the southwest, central, and northeastern portions of the county.

Ambient fine particle monitors in the Central Indiana area provide adequate coverage, as per 40 CFR, Part 58, Appendix D, 4.7. Indiana has placed fine particle monitors as per this guidance that based the number of monitors on the population of the metropolitan statistical area (MSA) and the design values for monitored areas. The monitors are therefore concentrated in the more urban areas where higher pollutant concentrations are expected. There are fine particle monitors located in nearby Madison, Howard, Henry and Tippecanoe Counties, which have MSAs with populations greater than 100,000. While these monitors were sited due to the proximity to the urban center of their respective MSAs, the resulting design values between these monitors are comparable with the latest 3 year values (2004-2006) and range between 12.9 and 13.6 $\mu g/m^3$.

Figure 3.3 shows the Central Indiana $PM_{2.5}$ monitoring network. Circles surrounding the monitors indicate the spatial scale of coverage for each of the monitors. The spatial scale of representation describes the physical dimensions of the air parcel measured at and near the monitor. In the rural areas, the air quality in the spatial coverage of the regional and urban monitor is considered to have similar concentrations. The monitors shown in Figure 3.3 are those closest to the unmonitored nonattainment areas.

A regional monitor has a spatial scale of representation which extends from tens to hundreds of kilometers from the monitoring site. The Mechanicsburg fine particle monitor, located in Henry County, represents a regional scale monitor. This monitor measures air quality representative of a geographic range that includes most of the Central Indiana nonattainment area. The Mechanicsburg fine particle monitor's current annual $PM_{2.5}$ 3-year design value (2004-2006) is 12.9 $\mu g/m^3$; indicating low, rural area readings.

An urban monitor has a spatial scale of representation which extends from 4 to 50 kilometers from the monitoring site. Mann Road fine particle monitor is an urban monitor and its spatial scale of representation extends into Hendricks, Morgan and Johnson Counties. Mann Road represents a downwind urban scale monitor, whose air quality monitoring extends out 50 kilometers, from Morgan and Johnson Counties while Hendricks County is located approximately 10 miles to the west of the Mann Road monitor. The Mann Road fine particle monitor's current annual $PM_{2.5}$ 3-year design value (2004-2006) is 13.8 $\mu g/m^3$.

A neighborhood monitor has a spatial scale of representation which extends from 0.5 to 4.0 kilometers from the monitoring site. Hamilton County would be considered downwind of the East 75th Street monitor, located approximately 4 kilometers to the south of Hamilton County. Washington Park, East 75th Street, West 18th Street and East Michigan Street fine particle monitors are neighborhood monitors with spatial extent up to 4 kilometers with uniform land use. While the neighborhood monitors represent a small portion of an urban area, the annual concentrations are fairly consistent for urbanized $PM_{2.5}$ concentrations. $PM_{2.5}$ concentrations in less populated areas and more rural settings would be expected to be lower.

Figure 3.3
Spatial Representation for Central Indiana $PM_{2.5}$ Monitoring Sites

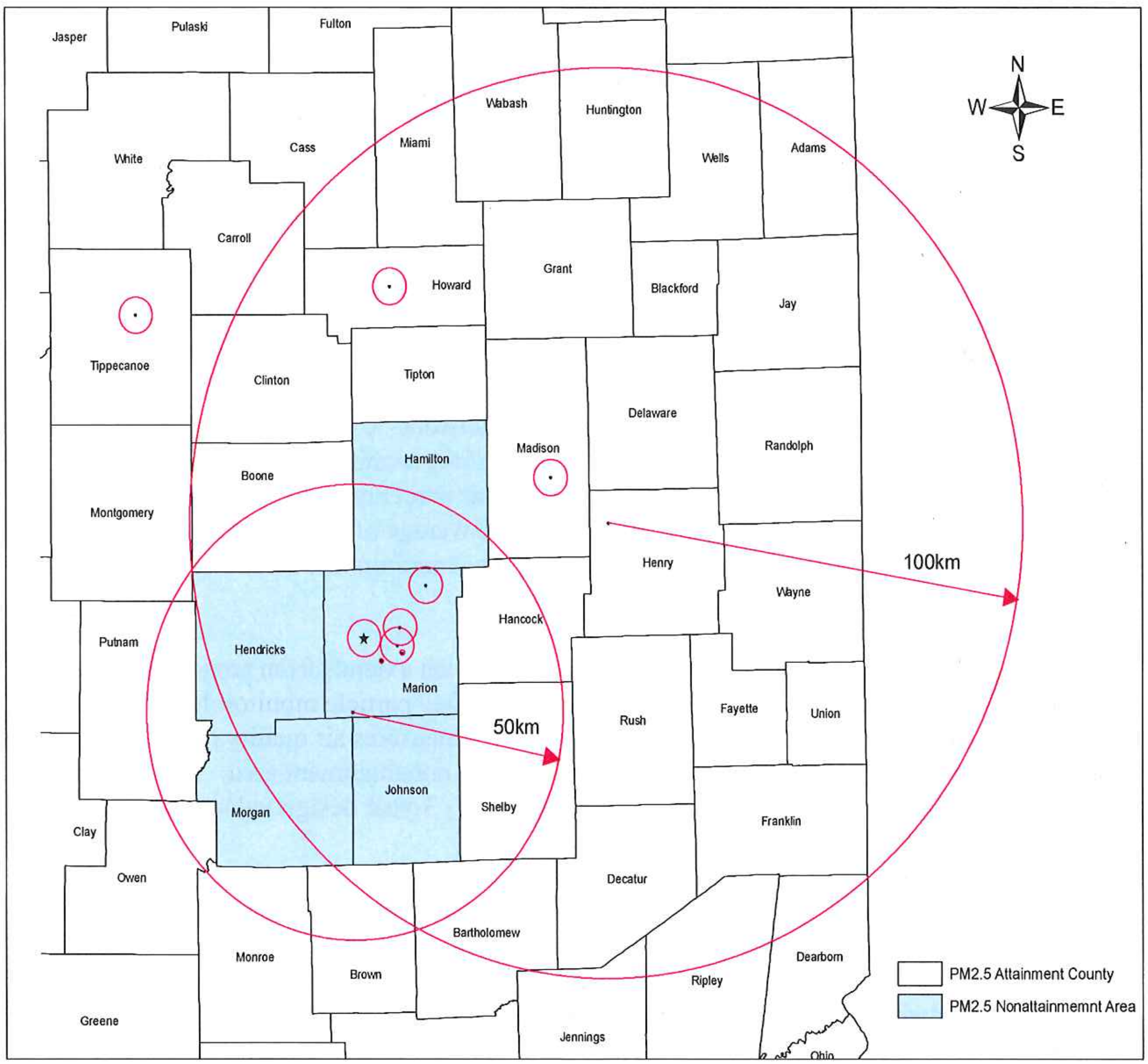


Table 3.6 highlights the fine particle monitors located outside the urban center of Indianapolis (Mann Road and E. 75th St.) and the monitors in Henry and Madison Counties with typically lower annual design values than the three monitors impacted by emissions from the Indianapolis urban core. Average differences in concentrations between the rural monitors and urban monitors range from 0.5 $\mu g/m^3$ to 1.5 $\mu g/m^3$. In addition, the Henry County monitor shows lower design values that would represent the eastern portion of Hamilton county. It is apparent that the higher annual fine particle concentrations are found in or near the urban center of Indianapolis. This fact is shown in the annual design values for each of the five Marion County fine particle monitors and surrounding county monitors over the past 7 years (2000-2006).

Table 3.6
Annual Design Values for Central Indiana from 2000 – 2006

County	Site	2000	2001	2002	2003	2004	2005	2006
Marion	Mann Road	15.19	14.78	15.22	14.53	12.92	16.1	12.49
Marion	Washington Park	17.75	16.58	16.55	15.45	14.31	16.39	14.14
Marion	E. 75th St.	16.36	16.25	15.68	14.67	13.44	16.8	12.75
Marion	W. 18th St.	16.78	17.14	14.24	16.21	14.96	18.06	14.12
Marion	E. Michigan St.	17	17.09	16.72	16.32	14.97	17.54	14.15
Madison	Anderson	15.55	14.61	14.91	14.35	12.83	16.06	12.06
Henry	Shenandoah H.S.	12.9	13.64	13.65	13.36	11.89	15.69	11.14
Howard	Kokomo	15.59	15.01	14.72	14.26	12.7	15.93	12.25
Tippecanoe	Lafayette	15.58	14.9	15.66	13.97	12.35	15.85	11.83
Vigo	Terre Haute	15.72	15.18	14.55	14.11	12.72	15.44	12.97
Vigo	Devaney School	13.79	13.41	13.39	13.40	12.13	15.12	12.20

U.S. EPA has developed the "Modeled Attainment Test Software" (MATS) to spatially interpret data, adjust spatial fields with modeled output gradients and multiply the fields by modeled RRFs. However, the $PM_{2.5}$ portion of MATS is not available at this time. U.S. EPA guidance recommends using nearby ambient data as well as modeled output to determine the concentrations in unmonitored areas. In the case of the unmonitored areas of Hamilton, Hendricks, Johnson and Morgan Counties, ambient monitored data in Marion County shows decreasing annual design values and future year modeled results at all Marion County fine particle monitors as falling below the annual fine particle standard.

The LADCO Round 5 modeling results for Marion County and other Central Indiana $PM_{2.5}$ monitoring sites are shown in Table 3.7. The 2009 modeled results show that the highest modeled concentrations will be 13.2 $\mu g/m^3$, at least 1.8 $\mu g/m^3$ below the annual fine particle NAAQS of 15.0 $\mu g/m^3$ with other modeled results in Marion County and other nearby areas being much lower. Modeling results for 2012 and 2018 indicate future year design values will continue to decrease in all areas. These results confirm that the adjacent U.S. EPA designated nonattainment counties of Hamilton, Hendricks, Johnson and Morgan will be in attainment of the annual fine particle standard by 2009 and continue through 2018 as modeled fine particle concentrations are less than 12 μg/m^3 and continue to decrease into the future.

Table 3.7
Modeling Results for Central Indiana $PM_{2.5}$ Monitors for 2009, 2012 and 2018

Monitor	Site	County	2005 Base Year	2009 Future Year	2012 Future Year	2018 Future Year
180650003	Shenandoah H.S.	Henry	13.3	11	10.8	10.3
180670003	Kokomo	Howard	14	11.9	11.7	11.1
180950009	Anderson	Madison	14	11.6	11.4	10.9
180970042	Mann Road	Marion	14.2	11.7	11.6	11
180970078	Washington Park	Marion	15.2	12.7	12.5	11.9
180970079	E. 75th St.	Marion	14.7	12.2	12.1	11.4
180970081	W. 18th St.	Marion	16.1	13.2	13.1	12.5
180970083	E. Michigan St.	Marion	15.9	13.2	13	12.4
181570008	Lafayette	Tippecanoe	13.7	11.5	11.4	10.9
181670018	Terre Haute	Vigo	14	11.6	11.5	11.1
181670023	Devaney School	Vigo	13.5	11.1	11	10.6

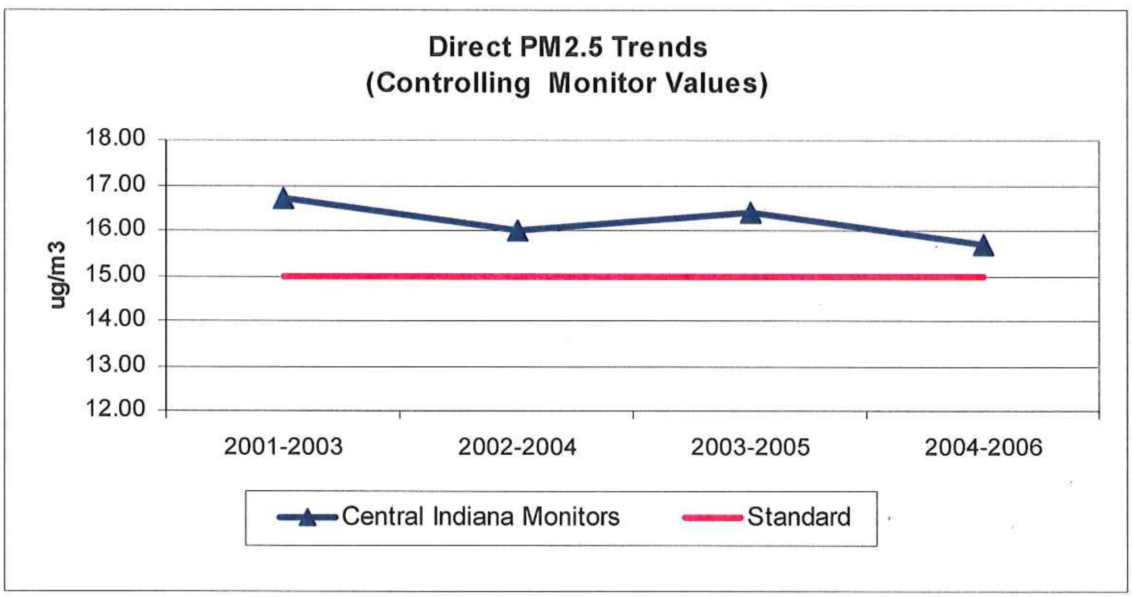
4.0 AIR QUALITY TRENDS

One benchmark for attainment of the annual fine particle standard is the area's design value. Table 4.1 shows the yearly trend in the design value for the area since 2003. This value is determined by the average of each monitor's PM2.5 values over a three-year period.

Table 4.1
Central Indiana Nonattainment Area's Annual Fine Particle Design Values

Year	Design Value [in $\mu g/m^3$] (Monitor Location)	3-Year Period
2006	15.7 (W. 18th Street)	2004-2006
2005	16.4 (W. 18th Street)	2003-2005
2004	16.0 (Michigan Street)	2002-2004
2003	16.7 (Michigan Street)	2001-2003
2002	17.0 (Washington Park)	2000-2002

Figure 4.1
Controlling Monitor Design Values



As shown in Figure 4.1, the data show a relatively continual decline since the implementation of federal control programs such as the NO_x SIP Call and the new engine and fuel standards.

To give a more complete picture of the air quality improvement in the nonattainment area, Chart 4.1 lists the design values for each of the ambient fine particle monitors in the nonattainment area:

Chart 4.1
Historical Design Values for Central Indiana Nonattainment Area from 2000-2006

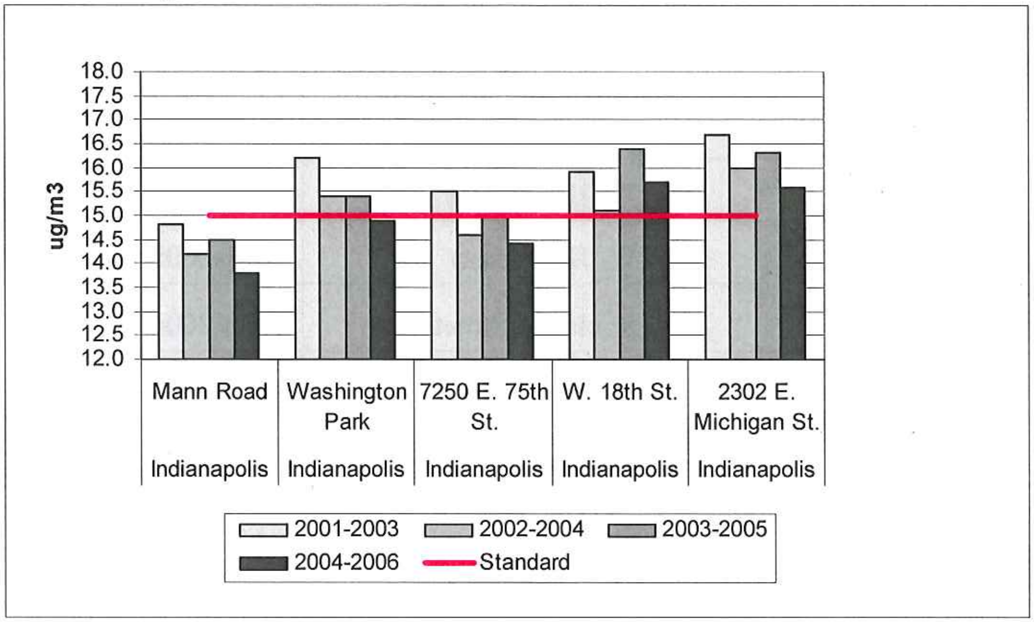
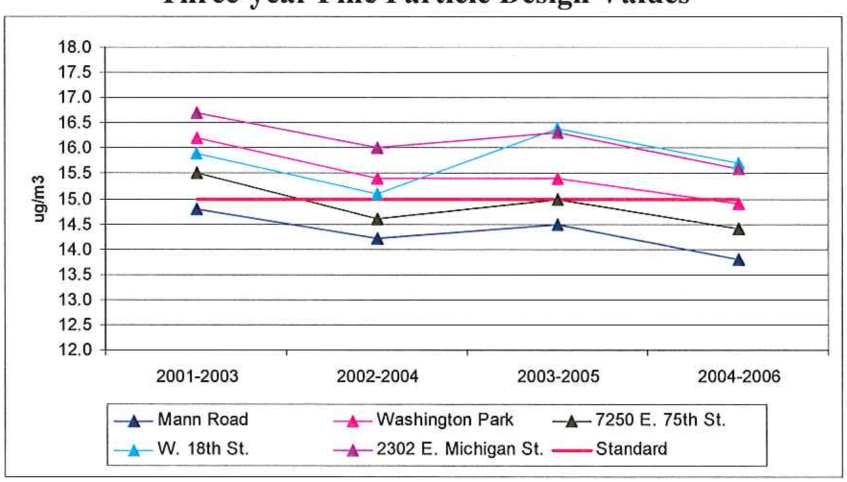


Figure 4.2 shows the design values for the Central Indiana fine particle nonattainment area from 2000 through 2006.

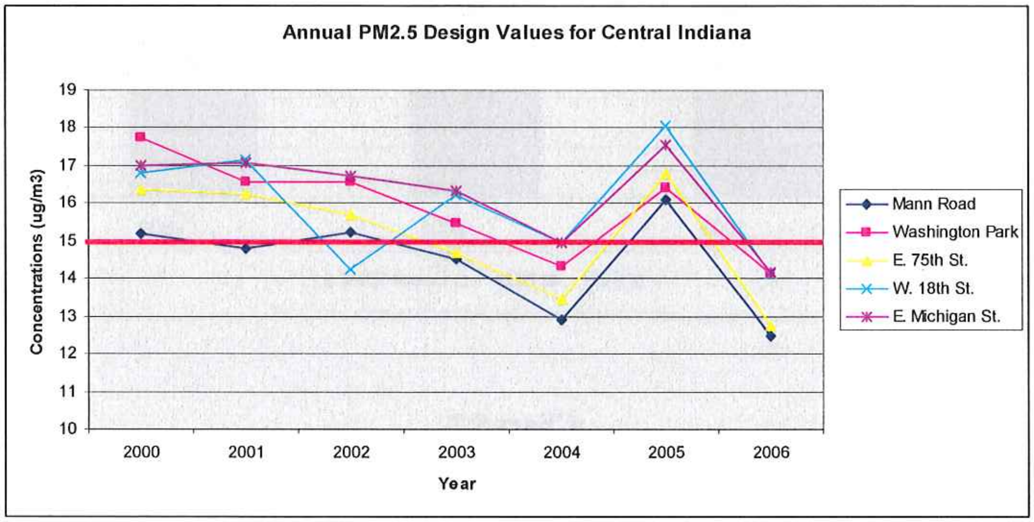
Figure 4.2
Three-year Fine Particle Design Values



If we take a look at the design value for each year between 2001 and 2006, as shown in Chart 4.1 and Figure 4.2, the annual design values for the Central Indiana fine particle monitors generally show a downward trend. In the figure, the NAAQS value for annual $PM_{2.5}$ of 15 $\mu g/m^3$ is identified by the red line. A general downward trend can be noticed with the exception of 2005. 2005 experienced extended meteorological events that led to several $PM_{2.5}$ episodes in which daily $PM_{2.5}$ concentrations in Central Indiana were extremely high. This in turn, weighed the annual $PM_{2.5}$ concentrations upward, as well as the latest 3-year design value for the area.

Figure 4.3 shows the significant decreases in annual fine particle concentrations monitored at each of the monitors in the Central Indiana area.

Figure 4.3
Annual $PM_{2.5}$ Values for Central Indiana



5.0 EMISSIONS TRENDS ANALYSIS

Charts 5.1, 5.2, 5.3 and 5.4 compare 2002 and 2005 actual SO_2, NO_x and direct $PM_{2.5}$ emissions, which were used in the modeling demonstration, to the projected 2009 emissions. Most of the projected 2009 emissions were lower than the actual 2002 emissions due to the various national, regional and local emission reductions that have been mandated. The only increases in emissions from 2002 to 2009, based on the current emission control strategies modeled were the point source category for direct $PM_{2.5}$ emissions. The increases were nominal amounts ranging from 1-32%. Despite these categorical increases, lower fine particle concentrations have and will continue to occur, due to the larger offsetting emission decreases from the other emission sectors.

Chart 5.1
Emissions Trends – All Anthropogenic Sources

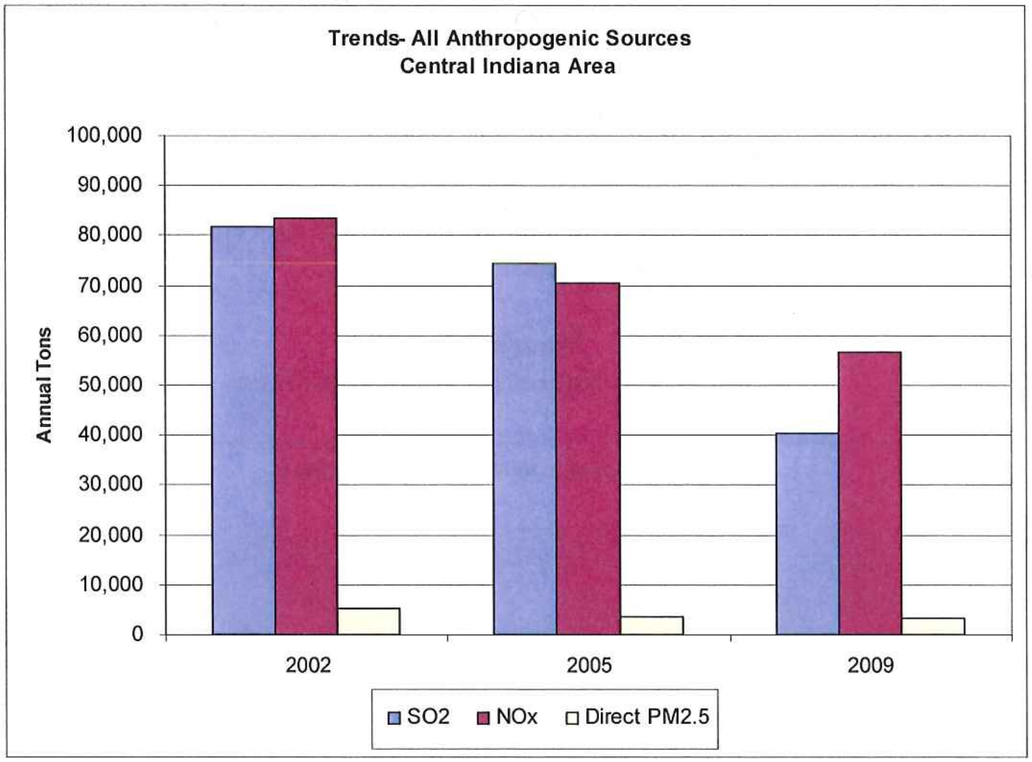


Chart 5.2
NO_x Emissions Trends

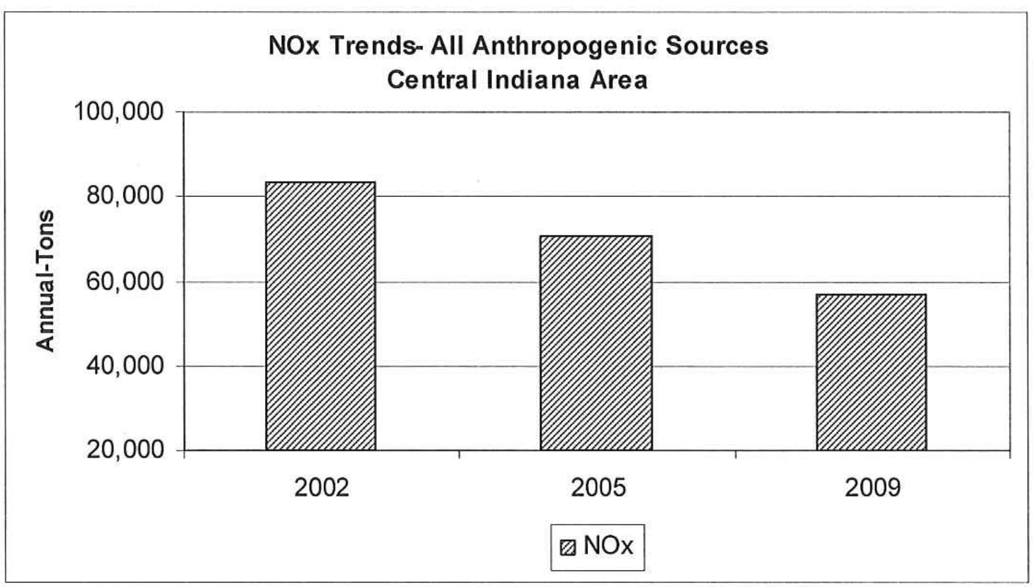


Chart 5.3
SO_2 Emissions Trends

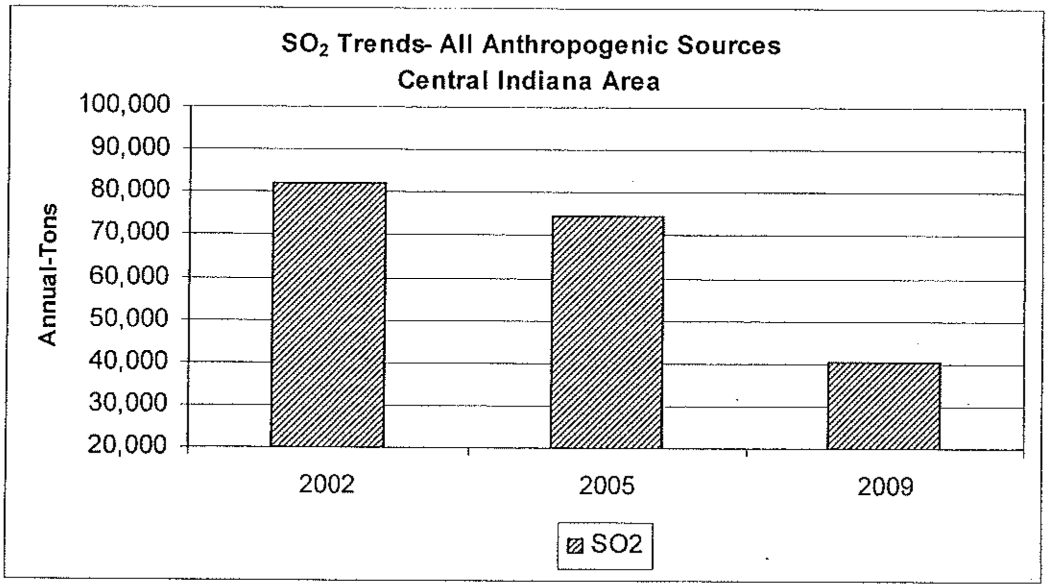


Chart 5.4
Direct $PM_{2.5}$ Emissions Trends

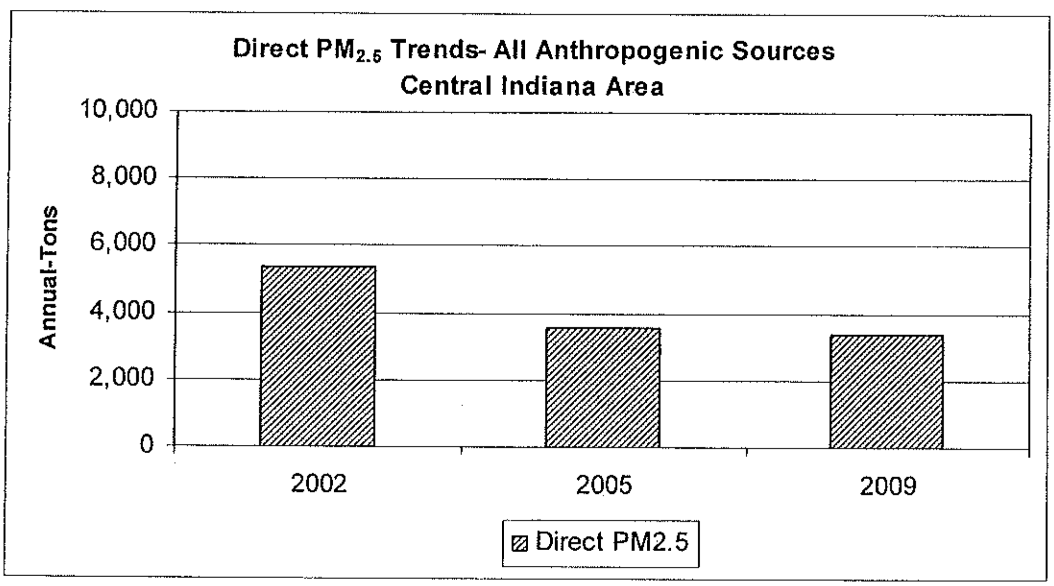


Table 5.1 shows the SO_2, NO_x and direct $PM_{2.5}$ emissions that were modeled, broken down by state and by emission source sectors (point, area, mobile, and non-road). The 2005 estimated emissions from each of the nonattainment counties in Central Indiana were pulled from the LADCO emissions inventory files (Appendix B).

Table 5.1
NO_x Emissions Inventory
(tons per year)

Sector	NOx 2002	NOx 2005	NOx 2009	% Reduction 2002-2009	% Reduction 2005-2009
Area	5,518.12	5,155.20	5,253.80	6.6	-1.9
Non-road	11,973.65	11,237.76	9,198.65	6.1	18.1
On-road	47,815.51	37,796.08	27,178.31	20.9	28.1
Point	18,003.69	16,492.75	15,076.42	8.4	8.6
Total	83,310.97	70,681.79	56,707.18	29.2	17.3

Table 5.2 shows the SO_2 emissions that were modeled, broken down by emission source sectors (point, area, mobile, and non-road). The projected 2009 emissions from each of the nonattainment counties in Central Indiana were pulled from the LADCO modeling emission inventory files.

Table 5.2
SO_2 Emissions Inventory
(tons per year)

Sector	SO_2 2002	SO_2 2005	SO_2 2009	% Reduction 2002 - 2009	% Reduction 2005 - 2009
Area	8,676.35	2,066.89	2,087.56	76.2	-1.0
Non-road	1,121.00	1,298.08	199.47	-13.6	84.6
On-road	1,533.99	506.46	159.30	66.9	68.5
Point	70,602.62	70,578.22	37,967.02	.03	46.2
Total	81,933.96	74,449.65	40,412.35	9.13	45.7

Table 5.3 shows the direct $PM_{2.5}$ emissions that were modeled, broken down by emission source sectors (point, area, mobile, and non-road). The projected 2009 emissions from each of the nonattainment counties in Central Indiana were pulled from the LADCO modeling emission inventory files.

Table 5.3
Direct $PM_{2.5}$ Emissions Inventory
(tons per year)

Sector	Direct $PM_{2.5}$ 2002	Direct $PM_{2.5}$ 2005	Direct $PM_{2.5}$ 2009	% Reduction 2002 - 2009	% Reduction 2005 - 2009
Area	2,934.95	1,012.25	1,105.19	62.3	-9.2
Non-road	847.73	909.54	731.69	13.7	14.6
On-road	842.37	668.53	493.74	46.1	32.1
Point	764.22	944.05	1,015.60	-32.9	-7.6
Total	5,389.27	3,534.37	3,346.22	34.4	5.32

The CAIR rule provides annual State caps for NO_x and SO_2 in two phases, with the Phase I caps for NO_x and SO_2 starting in 2009 and 2010, respectively. In response to U.S. EPA's rulemaking, IDEM adopted its state rule in 2006 based on the federal rule. IDEM's rule includes an annual and seasonal NO_x trading program, and an annual SO_2 trading program. This rule requires compliance beginning in 2009. Indiana's NO_x and SO_2 EGU budgets are shown in Table 5.4. EGU reductions occurring outside of the Central Indiana fine particle nonattainment area will have a positive affect on the area.

Chart 5.5
Statewide NO_x Emissions Trends

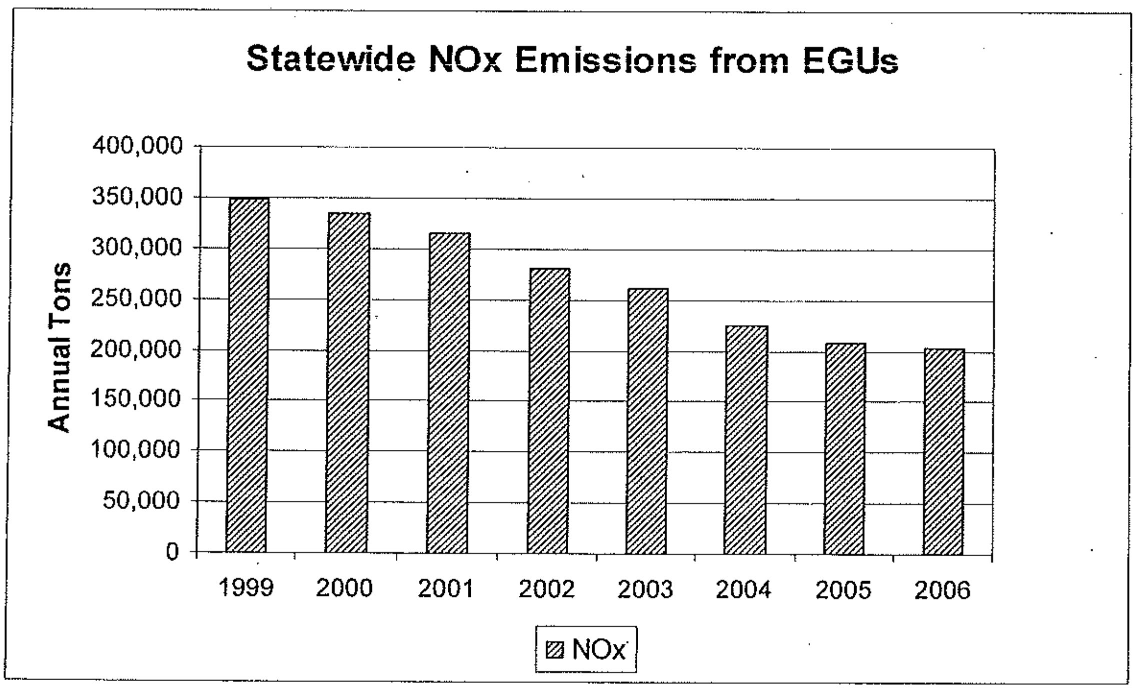


Table 5.4
Statewide Annual NO_x and SO_2 EGU Budget

STATEWIDE EGU NOx TRENDS	
Year	NO_x Emissions tons / annual
1999	347,217
2000	334,522
2001	315,420
2002	281,146
2003	260,980
2004	224,311
2005	207,982
2006	202,728
Budget 2009-2014	108,935
Budget 2015 and later	90,779

STATEWIDE EGU SO_2 TRENDS	
Year	SO_2 Emissions tons / annual
1999	941,852.4
2000	874,617.2
2001	795,505.6
2002	778,868.0
2003	804,828.6
2004	862,876.4
2005	870,811.8
2006	820,993.4
Budget 2010-2014	254,599
Budget 2015 and later	178,219

6.0 CONTROL STRATEGY

Several control measures already in place or being implemented over the next few years will reduce point, on-road mobile and non-road mobile source emissions. The Federal and State control measures included in the photochemical modeling for the future year design value and additional control measures due to be implemented, but were not included in the modeling are discussed in Sections 6.1 and 6.2. While being less certain of the impacts of VOC reductions, they are nevertheless beneficial for controlling fine particle levels. Therefore, control measures that reduce VOC emissions are included in the following sections.

6.1 MODELED CONTROL MEASURES

Federal Tier 2 motor vehicle standards require all passenger vehicles in a manufacturer's fleet, including light-duty trucks and sport utility vehicles (SUVs), to meet an average standard of 0.07 grams of NO_x per mile. Implementation began in 2004, and was completed in 2007. The Tier 2 standards also cover passenger vehicles over 8,500 pounds gross vehicle weight rating (the larger pickup trucks and SUVs), which are not covered by the current Tier 1 regulations. For these vehicles, the standards will be phased in beginning in 2008, with full compliance in 2009. The new standards require vehicles to be 77% to 95% cleaner than those on the road today. The Tier 2 standards also reduce the sulfur content of gasoline to 30 ppm beginning in January 2006. Most gasoline sold in Indiana prior to January 2006 had a sulfur content of about 500 ppm. Sulfur occurs naturally in gasoline, but interferes with the operation of catalytic converters on vehicles resulting in higher NO_x emissions. Lower sulfur gasoline is necessary to achieve the Tier 2 vehicle emission standards.

6.1.1 Heavy-Duty Gasoline and Diesel Highway Vehicles Standards

New U.S. EPA standards designed to reduce NO_x and VOC emissions from heavy-duty gasoline and diesel highway vehicles took effect in 2004. A second phase of standards and testing procedures that began in 2007, reduced particulate matter from heavy-duty highway engines, and also reduced highway diesel fuel sulfur content to 15 ppm since the sulfur can damage emission control devices. The total program is expected to achieve a 90% reduction in direct particulate matter (PM) emissions and a 95% reduction in NO_x emissions for these new engines using low sulfur diesel, compared to existing engines using higher-content sulfur diesel.

6.1.2 Large Non-Road Diesel Engines Standards

In May 2004, U.S. EPA promulgated new rules for large non-road diesel engines, such as those used in construction, agricultural and industrial equipment, to be phased in between 2008 and 2014. The non-road diesel rules also reduce the allowable sulfur in non-road diesel fuel by over 99%. Non-road diesel fuel currently averages approximately 3,400 ppm sulfur. This rule limits non-road diesel sulfur content to 500 ppm in 2006 and 15 ppm in 2010. The combined engine and fuel rules will reduce NO_x and PM emissions from large non-road diesel engines by over 90%, compared to current non-road engines using higher-content sulfur diesel.

6.1.3 Non-road Spark-Ignition Engines And Recreational Engines Standard

This new standard, effective in July 2003, regulates NO_x, VOCs and carbon monoxide (CO), for groups of previously unregulated non-road engines. The new standard applies to all new engines sold in the United States and imported after the standards went into effect. The standard applies to large spark-ignition engines (forklifts and airport ground service equipment), recreational vehicles (off-highway motorcycles and all-terrain vehicles), and recreational marine diesel engines. The regulation varies based upon the type of engine and vehicle.

The large spark-ignition engines contribute to ozone formation and ambient CO and PM levels in urban areas. Tier 1 of this standard was implemented in 2004 and Tier 2 started in 2007. Like the large spark-ignition engines, recreational vehicles contribute to ozone formation and ambient CO and PM levels. For the off-highway motorcycles and all-terrain vehicles, model year 2006, the new exhaust emission standard was phased-in to 50% and for model year 2007 and later, to 100%. Recreational marine diesel engines over 37 kilowatts are used in yachts, cruisers, and other types of pleasure craft. Recreational marine engines contribute to ozone formation and PM levels, especially surrounding marinas.

When all of the non-road spark-ignition engines and recreational engine standards are fully implemented, an overall 72% reduction in VOCs, 80% reduction in NO_x and 56% reduction in CO emissions are expected by 2020. These controls will help reduce ambient concentrations of ozone, CO and fine PM.

6.1.4 NO_x SIP Call

The U.S. EPA NO_x SIP Call required twenty-two (22) states to adopt rules that would result in significant emission reductions from large electric generating units (EGUs), industrial boilers, and cement kilns in the eastern United States. Indiana adopted this rule in 2001. Beginning in 2004, this rule accounts for a reduction of approximately thirty-one percent (31%) of total NO_x emissions statewide compared to previous uncontrolled years.

Twenty-one other states have also adopted these rules, including states surrounding Indiana. The result is that significant reductions have occurred upwind and within the Central Indiana fine particle nonattainment area because of the number of affected sources within the region.

6.1.5 Clean Air Interstate Rule (CAIR)

On May 12, 2005, the U.S. EPA promulgated the "Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone (Clean Air Interstate Rule); Revisions to Acid Rain Program; Revisions to the NO_x SIP Call", referred to as CAIR. This rule established the requirement for States to adopt rules limiting the emission of NO_x and sulfur dioxide (SO_2) and provided a model rule for the states to use in developing their rules to meet Federal requirements. The purpose of CAIR is to reduce interstate transport of precursors to fine particles and ozone.

CAIR applies to (1) any stationary, fossil-fuel-fired boiler or stationary, fossil-fuel-fired combustion turbines, a generator with nameplate capacity of more than 25 MWe producing electricity for sale and (2) for a unit that qualifies as a cogeneration unit during the 12 month period starting on the date that the unit first produces electricity and continues to qualify as a cogeneration unit, a cogeneration unit serving at any time a generator with a nameplate capacity of more than 25 MWe and supplying in any calendar year more than one-third of the unit's potential electric output capacity or 219,000 MWh, whichever is greater to any utility power distribution system for sale.

This rule provides annual State caps for NO_x and SO_2 in two phases, with the Phase I caps for NO_x and SO_2 starting in 2009 and 2010, respectively. Phase II caps become effective in 2015. The U.S. EPA is allowing the caps to be met through a cap and trade program if a State chooses to participate it the program.

In response to U.S. EPA's rulemaking, IDEM adopted its state rule in 2006 based on the model federal rule. IDEM's rule includes an annual and seasonal NO_x trading program, and an annual SO_2 trading program. This rule requires compliance effective January 1, 2009.

6.2 ADDITIONAL CONTROL MEASURES

This section provides a summary of the additional control measures that have been or will be implemented in the nonattainment area and were not included in the modeling demonstration.

6.2.1 Federal Controls

* Portable Fuel Container (Gas Can) Controls

U.S. EPA issued a final rule on February 26, 2007 (71 FR 15830) to regulate VOC emissions from portable gasoline containers, or gas cans. Portable fuel containers are consumer products used to refuel a wide variety of gasoline-powered equipment, including lawn and garden equipment, recreational equipment, and passenger vehicles that have run out of gas. The proposed standards will reduce hydrocarbon emissions from evaporation, permeation, and spillage. These standards will significantly reduce benzene and other toxics, as well as VOC more generally.

The rule proposed a performance-based standard of 0.3 grams per gallon per day of hydrocarbons, based on the emissions from the can over a diurnal test cycle. The standard will apply to gas cans manufactured on or after January 1, 2009. EPA also proposed test procedures and a certification and compliance program, in order to ensure that gas cans meet the emission standard over a range of in-use conditions. The proposed standards will result in the use of best available control technologies, such as durable permeation barriers, automatically closing spouts, and cans that are well-sealed.

Emission reductions expected to be 18% by 2009, 54% reduction at full implementation in 2015.

* Small Non-Road Engine Rule

On April 17, 2007, U.S. EPA proposed a rule to control emissions from new gasoline-powered small non-road engines, including lawn and garden equipment (<25 hp) and recreational watercraft. Under the proposed rule, the exhaust emission standards for Class I non-road engines will take effect in 2012 and for Class II engines in 2011. Watercraft standards will take effect in 2009. EPA anticipates that when fully implemented, the proposed standards will result in a 70 percent reduction in hydrocarbon and NO_x emissions and a 20 percent reduction in CO from new engines' exhaust, as well as a 70 percent reduction in evaporative emissions.

6.2.2 Indiana Statewide Controls

IDEM is proposing to implement several statewide VOC control rules. Through MRPO consultation, the other MRPO states (Illinois, Indiana, Michigan, Ohio, and Wisconsin) have also agreed to implement a series of similar controls to address regional ozone and particulate matter nonattainment areas in the upper Midwest. The rules will apply region-wide to consumer and commercial products, automobile refinishing operations, cold cleaning degreasing, architectural and industrial maintenance (AIM) and Stage I vapor recovery.

*　Consumer and Commercial Products (326 IAC 8)
Proposed new rule to adopt OTC model rule with additional product coverage and more stringent VOC limits (14.2 % reduction beyond Federal Part 59 rule, for a total reduction of 21% from uncontrolled emissions.

*　Architectural and Industrial Maintenance (AIM) Coatings (326 IAC 8-14)
This rule will adopt more stringent VOC limits for AIM coatings based on OTC model rule, 21% reduction beyond Federal Part 59 limits.

*　Automobile Refinishing Operations (326 IAC 8-10)
This rule will extend existing regulations statewide. A reduction of 55% is expected from uncontrolled emissions, 24% reduction beyond Federal Part 59 limits.

*　Cold Cleaning Degreasing (326 IAC 8-9)
The existing regulation establishes a vapor pressure limit for solvents used in cold cleaning degreasers in Clark and Floyd Counties. Reducing the vapor pressure of the solvent used in turn results in decreased emissions of VOC and HAP. IDEM proposed new regulations to extend this requirement statewide.

*　Stage I Vapor Recovery (326 IAC 8-4)

The existing regulation requires gasoline dispensing facilities with a monthly gasoline throughput of 10,000 gallons per month or greater to vapor balance systems to collect gasoline vapors displaced during the transfer of gasoline between storage tanks and delivery trucks. The proposed rulemaking will amend 326 IAC 4-1 to apply to all gasoline dispensing facilities regardless of when the storage tank was installed. IDEM estimates that the rules requiring submerged loading and vapor balancing will achieve a 90% reduction in VOC emissions versus uncontrolled underground storage tank loading.

6.2.3 Regional Controls

Significant emission reductions occurred in 2007 as a result of the closure of several facilities located in the Central Indiana. Since these reductions were not necessary to demonstrate attainment they were not included in the modeling demonstration or the 2009 projected emission inventories. These additional emission reductions provide additional assurance that the area will attain and maintain the standard.

7.0 SUPPLEMENTAL ANALYSIS

U.S. EPA's fine particle modeling guidance requires states to submit a basic supplemental analysis demonstration if future year modeled design values are "close" to the standard (> 14.5 $\mu g/m^3$) in order to determine if additional information support the modeling result (see "Guideline on the Use of Models and Other Analysis in Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze (April 2007").

Because the 2009 future year design value for the Central Indiana nonattainment area is significantly below the annual fine particle standard (13.2 μg/m^3), Indiana is including a basic supplemental analysis to demonstrate that the area will attain the standard by the required date of April 5, 2010.

The supplemental analysis relies on existing modeling conducted by LADCO for CAIR and reductions from additional control measures to be implemented that were not included in the modeling analyses. The supplemental analysis further supports the fact that the design value will continue downward and leads to the conclusion that the nonattainment area will comply with the fine particle standard by its attainment date.

7.1. LADCO'S ROUND 5 MODELING

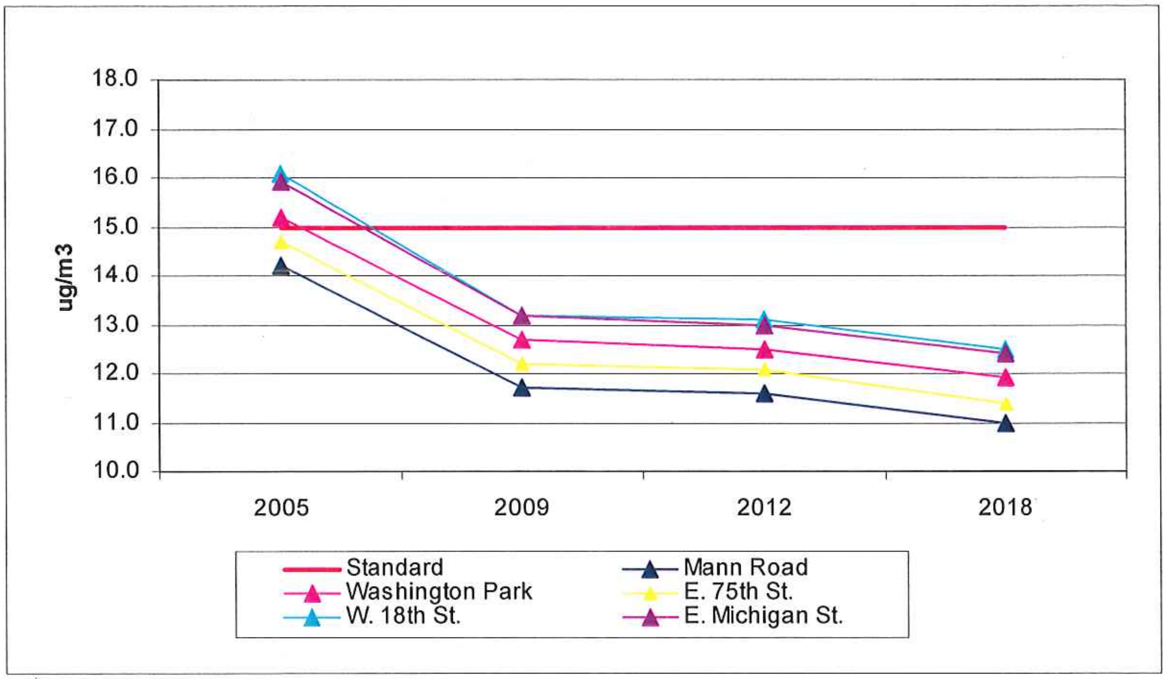
The Lake Michigan Air Directors Consortium (LADCO) conducted modeling to determine the impact of CAIR in the Midwest. LADCO's modeling used the Comprehensive Air Quality Model with extensions (CAMx) applied to the year 2005 meteorology, as processed by Mesoscale Model (MM5). Emissions input into CAMx included sulfur dioxide, nitrogen oxides, volatile organic compounds, ammonia and direct $PM_{2.5}$ for 2005. The modeling was based on 2003 through 2006 design values. Future year modeling for 2009, 2012, and 2018 was conducted and the future year design values were determined, as shown below in Table 7.1.

Table 7.1
LADCO's Round 5 Modeling Results for the Clean Air Interstate Rule

Monitor ID	Monitor Name	County	Design Value 2003-2006	Basecase with CAIR 2009	Basecase with CAIR 2012	Basecase with CAIR 2018
			(μg/m^3)	(μg/m^3)	(μg/m^3)	(μg/m^3)
180970042	Mann Road	Marion	14.2	11.7	11.6	11
180970078	Washington Park	Marion	15.2	12.7	12.5	11.9
180970079	E. 75th St.	Marion	14.7	12.2	12.1	11.4
180970081	W 18th St	Marion	16.1	13.2	13.1	12.5
180970083	E. Michigan St.	Marion	15.9	13.2	13	12.4

Results of the LADCO CAIR modeling show that all Central Indiana Counties will attain the annual NAAQS for fine particles of 15 μg/m^3 by 2009. As shown in Figure 7.1, future year modeled annual fine particle concentrations for 2009 will be 16% to 18% lower than baseline annual fine particle design values, 18% to 19% lower in 2012 and 22% to 23% lower in 2018 and will continue to decrease thereafter.

Figure 7.1
Graph of Modeling Results for Central Indiana $PM_{2.5}$ Monitors for 2009, 2012 and 2018



7.2 LADCO'S ROUND 5 SPECIATED MODELED ATTAINMENT TEST RESULTS

The Speciated Modeled Attainment Test (SMAT) is the attainment test for annual fine particles. To determine the future year annual fine particle concentrations, speciated data is calculated. The different species that were modeled and are associated with fine particles include sulfates, nitrates, organic carbon, elemental carbon, ammonium, particle bound water, "other" primary inorganic fine particles and passively collected mass. The SMAT results from LADCO's Round 5 modeling are listed below. Percent ranges of the modeled results from the five fine particle monitors in Central Indiana were broken down into these speciated constituents of fine particle emissions. The percent change from the observed and spatial fields' speciated data in 2005 to the future year modeled results for 2009 are listed below in Table 7.2.

Table 7.2
LADCO's Round 5 SMAT Modeling Results for Central Indiana
(Percent reduction from observed to modeled concentrations)

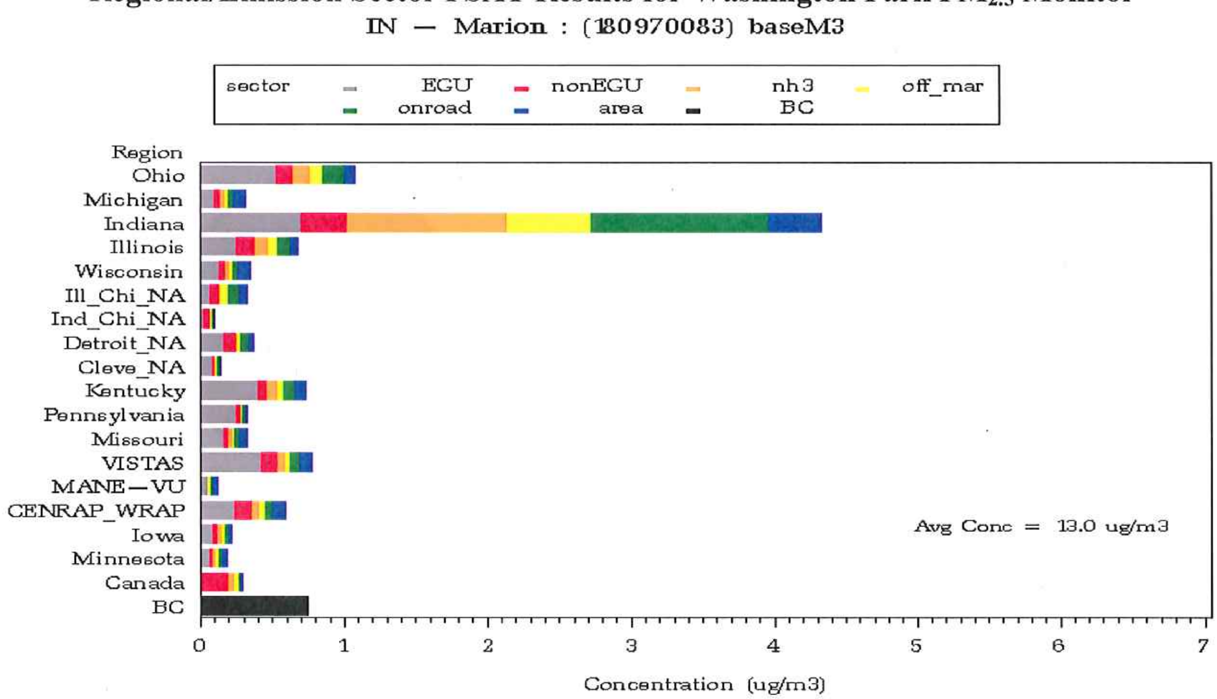
Species of $PM_{2.5}$	2009
Sulfates	23% - 26%
Nitrates	0% - 6%
Organic Carbon	0% - 3%
Elemental Carbon	17%
Ammonium	16% - 21%
Particle Bound Water	19% - 25%

The results show that sulfate, elemental carbon and ammonium concentration decreases are projected to occur by at least 16% in the future year 2009. Lesser nitrate reductions are projected to occur, up to 6%, with organic carbon reductions occurring up to 3%. LADCO modeling shows good performance for sulfates and elemental carbon predicted baseline concentrations, slight over-prediction for nitrate concentrations and under-predictions of organic carbon concentrations. Overall, model performance is adequate for State Implementation Plan (SIP) planning and gives a good idea of the effects of emissions reductions from national emission control measures for Central Indiana.

7.3 LADCO'S ROUND 5 PARTICULATE SOURCE APPORTIONMENT RESULTS

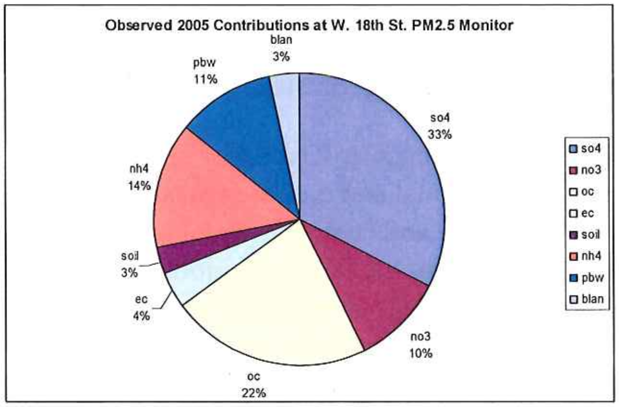
Particulate Source Apportionment (PSAT) modeling was conducted by LADCO. The results of the PSAT Round 5 modeling show the contributions from regional and emission sectors for each monitor that was modeled. Chart 7.1 below shows the regional and emission sector contributions for the Washington Park fine particle monitor, with Indiana being the biggest regional contributor. The PSAT Round 5 modeling results show the majority of emission sector contributions to fine particle concentrations at Washington Park come from on-road, ammonium emission sources, electric generating units, off-road (including marine, aircraft and railroad) and area sources. These results are considered to be representative of the entire Central Indiana area as mobile, ammonium and EGU emissions impact the entire area.

Chart 7.1
Regional/Emission Sector PSAT Results for Washington Park $PM_{2.5}$ Monitor



The following pie charts depict the species contributions to fine particle concentrations at the Central Indiana monitors. The pie charts include both the observed 2005 contributions and future year 2009 modeled contributions for each monitor. Since the monitors are in close proximity of each other, results are fairly similar in the distribution of species concentrations among the monitors. Charts 7.2 through 7.6 cover the five fine particle monitors in the Central Indiana area that are used to determine compliance with the annual NAAQS.

Chart 7.2
Pie Charts of the Species Modeled Contributions to W. 18th St. $PM_{2.5}$ Monitor
(Observed Concentration = 16.1) (Modeled Concentration = 13.2)



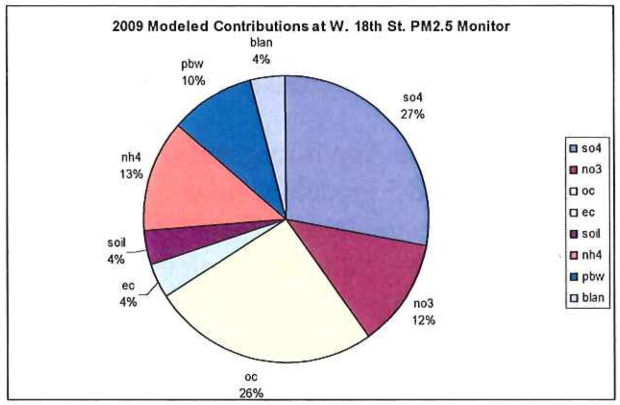
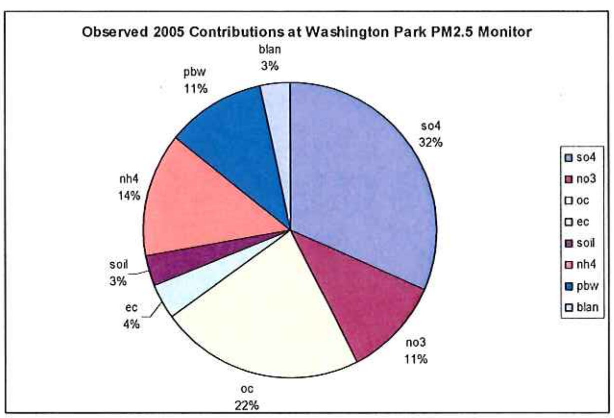


Chart 7.3
Pie Charts of the Species Modeled Contributions to Washington Park $PM_{2.5}$ Monitor
(Observed Concentration = 15.2) (Modeled Concentration = 12.7)



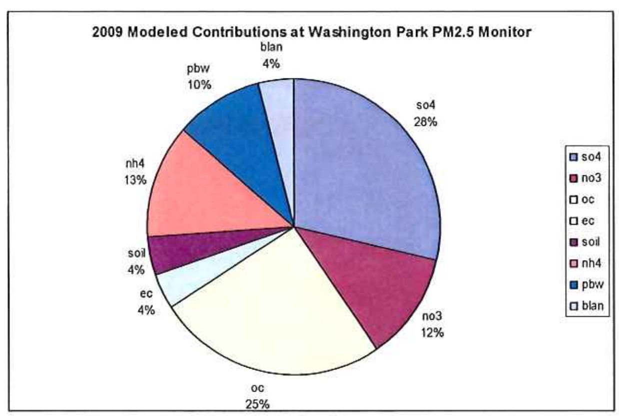
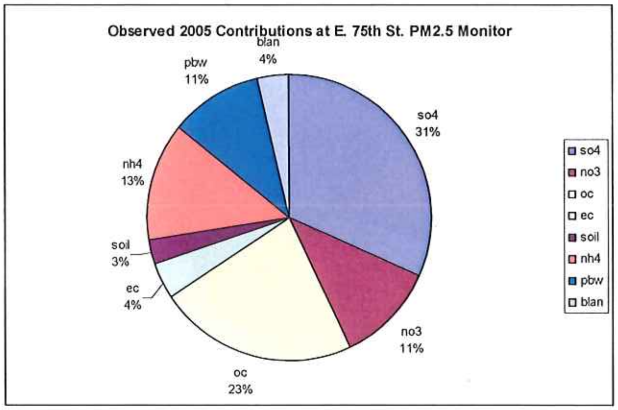


Chart 7.4

Pie Charts of the Species Modeled Contributions to E. 75th St. $PM_{2.5}$ Monitor

(Observed Concentration = 14.7) (Modeled Concentration = 12.2)



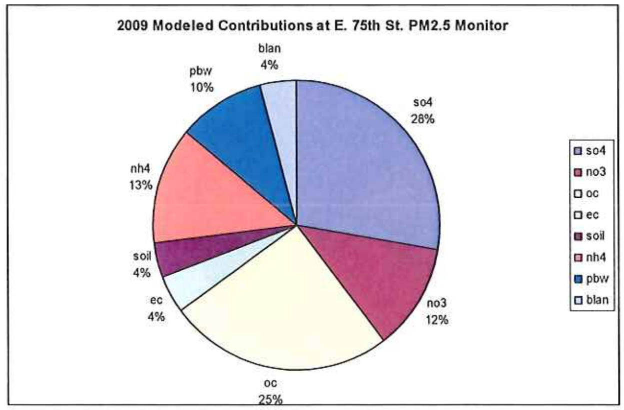
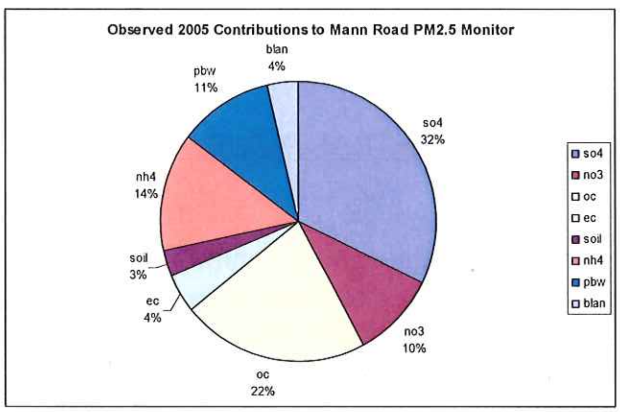


Chart7.5

Pie Charts of the Species Modeled Contributions to Mann Road $PM_{2.5}$ Monitor

(Observed Concentration = 14.2) (Modeled Concentration = 11.7)



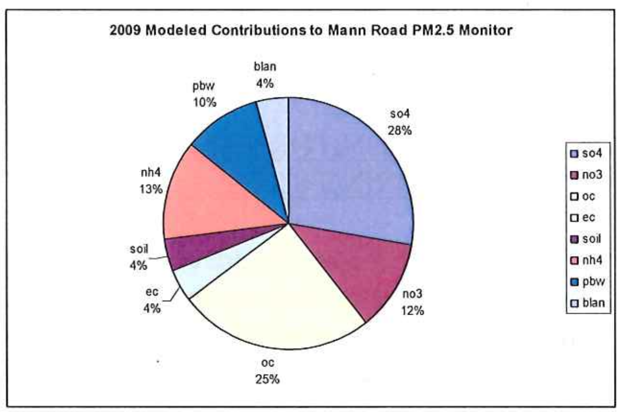
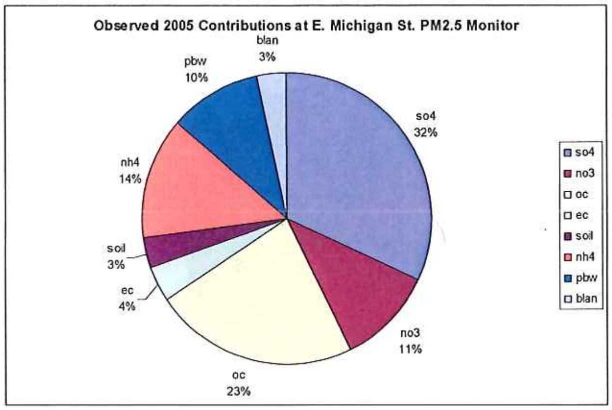
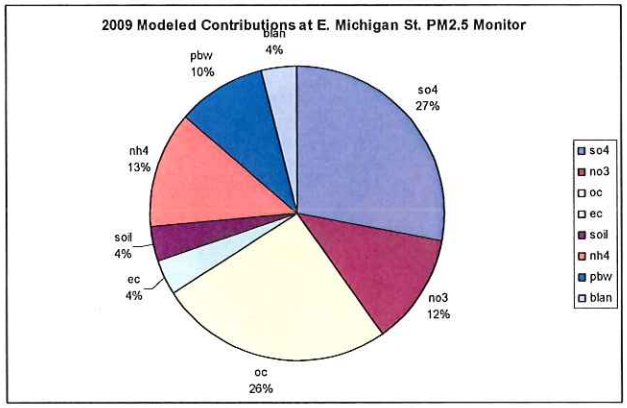


Chart 7.6

Pie Charts of the Species Modeled Contributions to E. Michigan St. $PM_{2.5}$ Monitor
(Observed Concentration = 15.9) (Modeled Concentration = 13.2)



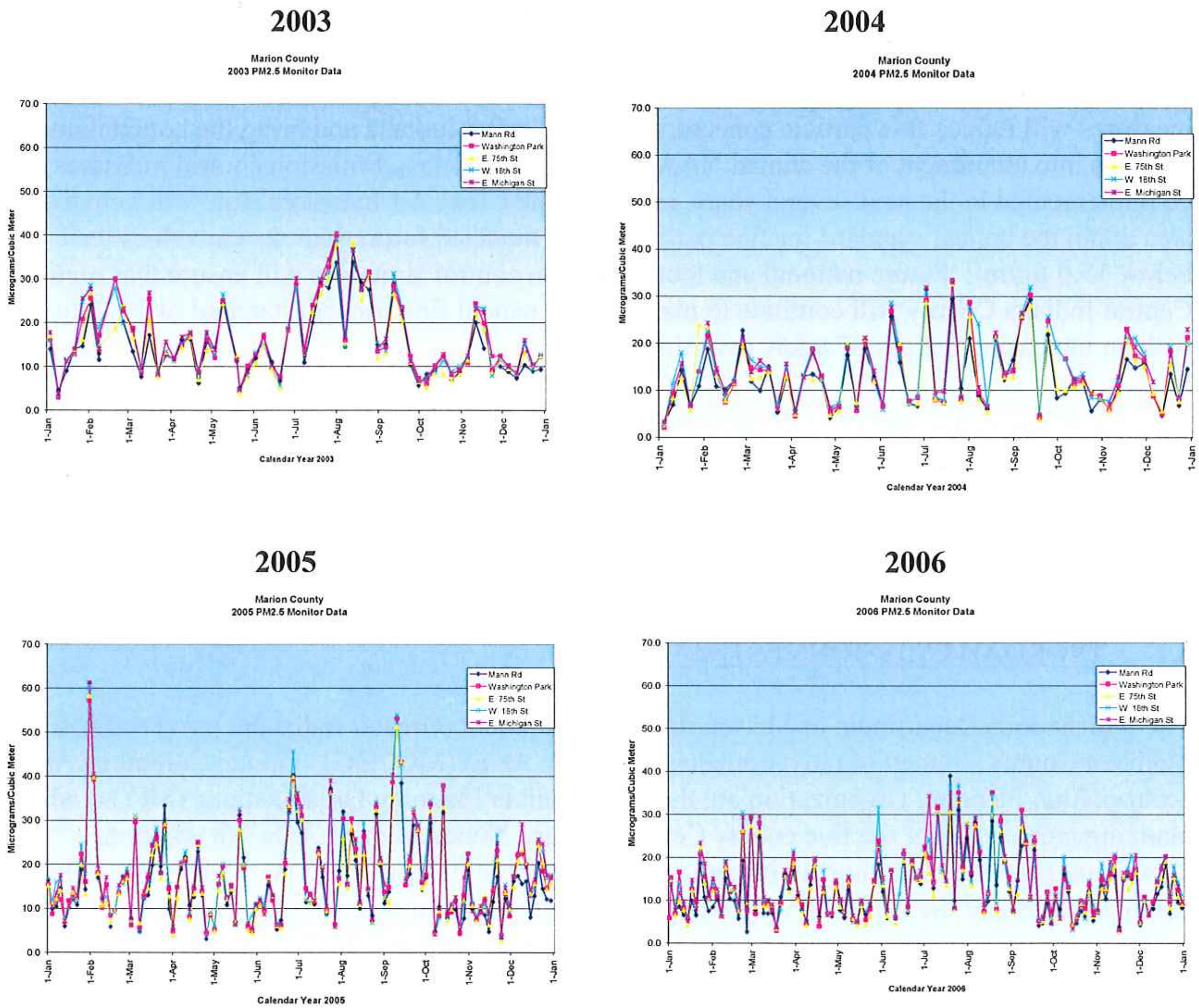


Results of the Round 5 PSAT modeling for Central Indiana fine particle monitors show the highest pollutant contributors to basecase and future year fine particle concentrations are sulfate, organic carbon, ammonium and nitrate. Future year modeling shows decreases in sulfates (due to the emission reductions from CAIR) and ammonium. The future year modeling did show slight increases in organic carbon and nitrates from the basecase modeled concentrations. However, these increases are offset by the larger decreases in sulfates.

7.4 DAILY MONITORED DATA COMPARISON FOR CENTRAL INDIANA $PM_{2.5}$ MONITORING SITES

The consistent PSAT results are evident in the monitoring data throughout Central Indiana, as the trends for each Central Indiana monitor follow each other on a daily and annual basis. The daily monitored data was compared for each year between 2003 through 2006. Analyzed for all monitored fine particle days, all five Central Indiana fine particle monitors had average daily impacts within 3 $\mu g/m^3$ and average annual impacts between 1.5 and 2.5 $\mu g/m^3$ of each other, indicating a more regional nature to the fine particle concentrations in the area. As can be seen in Figure 7.2, all of the Central Indiana fine particle monitors track fairly close together each year with unusually higher fine particle episodes evident in 2005.

Figure 7.2
Daily Monitoring Data Comparison for Central Indiana $PM_{2.5}$ Monitors



7.5 SUMMARY OF ATTAINMENT TEST MODELING RESULTS

Indiana, in conjunction with the MRPO has performed technical analyses of the air quality in the Midwest in order to develop SIPs for areas that do not presently attain current NAAQS, including Central Indiana. LADCO provided the technical support in order to conduct the air quality analyses necessary to demonstrate future-year compliance with the current annual fine particle NAAQS. Results of the attainment test for annual fine particles for the Central Indiana area show that the area will attain the current annual fine particle NAAQS by 2009, one year before the attainment date deadline of 2010.

Additional analyses, using particulate source apportionment and outputs from the Speciated Modeled Attainment Test show that regional, emission sector and species contributions to fine particle concentrations overall in Central Indiana will be reduced further in the future. Species contributions are fairly consistent between all Central Indiana monitors and emissions reductions will result in similar decreases in fine particle concentrations, as well as species contributions to fine particle composition throughout Central Indiana. Sulfates are the highest contributing species of fine particles composition in Central Indiana and will be reduced as a result of the Clean Air Interstate Rule and other emission control regulations.

LADCO modeling for future year design values shows that existing national emission control measures will reduce fine particle concentrations in Central Indiana and bring the nonattainment counties into attainment of the annual NAAQS for fine particles. Emission control measures to be implemented in the next several years, including the Clean Air Interstate Rule will help the area attain the annual standard for fine particles with modeled future year design values well below 15.0 $\mu g/m^3$. Future national and local emission control strategies will ensure that each Central Indiana County will continue to maintain the annual fine particle standard of 15.0 $\mu g/m^3$ with an increasing margin of safety over time.

8.0 MOBILE SOURCE EMISSION BUDGETS

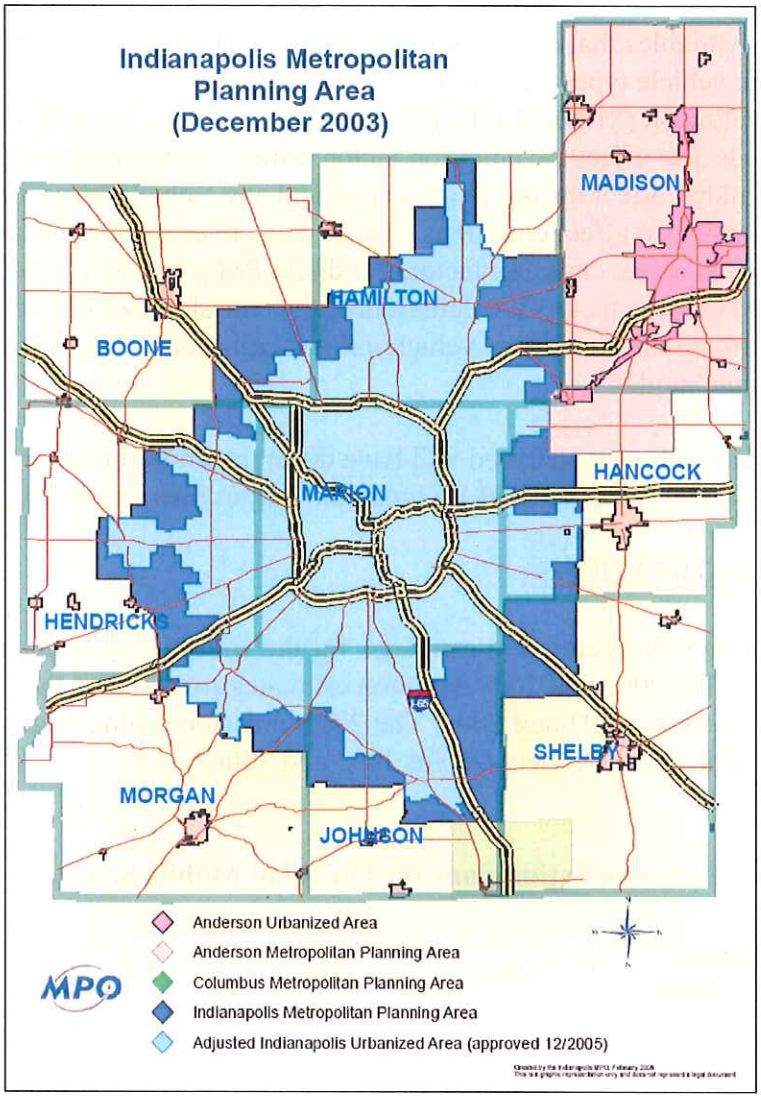
The following is a summary of the detailed mobile input and output calculation files located in Appendix H.

8.1 ON-ROAD EMISSIONS ESTIMATES

The Indianapolis Department of Metropolitan Development (Greater Indianapolis) (DMD), the Madison County Council of Governments (Anderson Area) (MCCOG), and the Columbus Area Metropolitan Planning Organization are the Metropolitan Planning Organizations (MPOs) whose planning areas intersect the five county Central Indiana Nonattainment Area. In addition, significant portions of the nonattainment area are not under the jurisdiction of any MPO. These planning areas and the current $PM_{2.5}$ nonattainment area are illustrated in Figure 8.1.

An interagency consultation group consists of representatives from the three MPOs, the Indiana Department of Transportation, the Indiana Department of Environmental Management, the Federal Highway Administration, and local transit and environmental quality providers jointly determine regional significance. Primary responsibility for modeling emissions falls under the purview of DMD, which runs the MOBILE6 model to arrive at emissions rates, and its regional travel model to develop estimates of vehicle miles of traveled (VMT) for all areas but the MCCOG planning area, for which MCCOG administers its own travel model. DMD then compiles all results into a regional emissions analysis, which all MPOs then adopt following a public involvement period.

Figure 8.1
Central Indiana MPO Jurisdictions



These models simulate the traffic in the area and are used to predict what the traffic will be like in future years given growth expectations. The models are used mostly to identify where travel capacity will be needed and to determine the infrastructure requirements necessary to meet that need. They are also used to support the calculation of mobile source emissions. The travel demand forecast model is used to predict the total daily VMT and MOBILE6 is used to calculate the emissions per mile. The product of these two outputs, once combined, is the estimated total amount of pollution emitted by the on-road vehicles for the area analyzed.

8.2 OVERVIEW

Broadly described, MOBILE6 is used to determine "emission factors", which are the average emissions per mile (grams/mile) for direct $PM_{2.5}$ and $PM_{2.5}$ precursors including NO_x and SO_2. There are numerous variables that can affect the emission factors. The vehicle-fleet (vehicles on the road) age and the vehicle types have a major effect on the emission factors. The facility type the vehicles are traveling on (MOBILE6 facility types are Freeway, Arterial, Local and Ramp) and the vehicle speeds also affect the emission factor values. Meteorological factors such as air temperature and humidity affect the emission factors and any Vehicle Inspection/Maintenance program in the area will also affect emissions. These data are estimated using the *best available data* (see section 8.3) to create emission factors for direct $PM_{2.5}$ and $PM_{2.5}$ precursors including NO_x and SO_2. After emission factors are determined, the emission factor(s) must be multiplied by the VMT to determine the quantity of vehicle-related emissions. This information derives from the travel demand model.

It should be noted that each year analyzed will have different emission factors, volumes, speeds and likely some additional links. MOBILE6 input and output files can be found in Appendix H.

8.3 EMISSION ESTIMATIONS

Table 8.1 outlines the on-road emission estimates for the entire nonattainment area for the years 2002, 2005 and 2009. The 2002 and 2009 emission estimates are based on the actual travel demand model network for the years 2002 and 2009. The 2005 emission estimates are interpolated values based on the travel demand model network for 2002 and 2006.

Table 8.1
Emission Estimations for On-Road Mobile Sources

Central Indiana Nonattainment Area	2002	2005	2009
$PM_{2.5}$ (tons/year)	842.37	668.53	493.74
NO_x (tons/year)	47,815.51	37,796.08	27,178.31

Table 8.2 contains the motor vehicle emission estimates for the base year of 2002 and the motor vehicle emission budget (Budget) for 2009.

Table 8.2
Mobile Vehicle Emission Budgets

	2002	2009
$PM_{2.5}$ (tons/year)	842.37	518.43
NO_x (tons/year)	47,815.51	28,537.23

Consistent with the federal implementation rule for fine particles, Indiana does not consider sulfur dioxide (SO_2) emissions from mobile sources to be a significant contributor to fine particle levels for this nonattainment area, as they constitute less than two percent (1.5%) of the area's projected total SO_2 emissions.

This document creates a motor vehicle emissions budget (Budget) for 2009 for the entire nonattainment area that describes the maximum on-road emissions that cannot be exceeded from the year 2009 and beyond. A reasonable buffer has been applied to the Budget for the year 2009. The emission estimates are derived from the MPO's travel demand models and MOBILE6 as described above. Buffers are used to accommodate the wide array of assumptions that are factored into the calculation process. Since assumptions change over time, it is necessary to have a buffer that will accommodate the impact of refined assumptions in the process. With the buffer applied to the 2009 Budget, the 2009 total $PM_{2.5}$ and NO_x emissions remain well below the base year emissions referenced in Table 8.1.

All methodologies, latest planning assumptions and the safety margins were determined through the interagency consultation process.

9.0 CONTINGENCY MEASURES

Contingency measures to be considered will be selected from a comprehensive list of measures deemed appropriate and effective at the time the selection is made. Listed below are example measures that may be considered. The selection of measures will be based upon cost-effectiveness, emission reduction potential, economic and social considerations or other factors that IDEM deems appropriate. IDEM will solicit input from interested and affected persons in the nonattainment area prior to selecting appropriate contingency measures. All of the listed contingency measures are potentially effective or proven methods of obtaining significant reductions of fine particle precursor emissions. Because it is not possible at this time to determine what control measure will be appropriate at an unspecified time in the future, the list of contingency measures outlined below is not comprehensive. Indiana anticipates that if contingency measures should ever be necessary, it is unlikely that a significant number (i.e., all those listed below) will be required.

1) Alternative fuel and diesel retrofit programs for fleet vehicle operations.
2) Require NO_x or SO_2 emission offsets for new and modified major sources.
3) Require NO_x or SO_2 emission offsets for new and modified minor sources.
4) Increase the ratio of emission offsets required for new sources.
5) Require NO_x or SO_2 controls on new minor sources (less than 100 tons).
6) Wood stove change-out program.
7) Various emissions reduction measures or dust suppressant for unpaved roads and/or parking lots.
8) Idling Restrictions.
9) Broader geographic applicability of existing measures.

10) One or more transportation control measures sufficient to achieve at least a half a percent (0.5%) reduction in actual area-wide precursor emissions. Transportation measures will be selected from the following, based upon the factors listed above, after consultation with affected local governments:

a) Trip reduction programs, including, but not limited to, employer-based transportation management plans, area wide rideshare programs, work schedule changes, and telecommuting.

b) Transit improvements.

c) Traffic flow improvements.

d) Other new or innovative transportation measures not yet in widespread use that affected state and local governments deem appropriate.

No contingency measure shall be implemented without providing the opportunity for full public participation during which the relative costs and benefits of individual measures, at the time they are under consideration, can be fully evaluated.

10.0 PUBLIC PARTICIPATION

In accordance with Section 100 (a) (2) of the CAAA, Indiana published notification for a public hearing and solicitation for public comments concerning the draft *Fine Particle Attainment Demonstration and Technical Support Document for Central Indiana* in The Indianapolis Star, Indianapolis, Indiana on or before March 20, 2008.

A public hearing to receive comments on the redesignation request was held on April 21, 2008, in the History Reference Room 211, at the Indiana State Library, 140 North Senate Avenue, Indianapolis, Indiana and no comments were received. The public comment period closed on April 25, 2008. Appendix I includes a copy of the public notice, certifications of publication, the transcript from the public hearing, public hearing attendance record, copies of all written comments received and a summary of comments received that includes IDEM's responses, as applicable.

11.0 CONCLUSION

Monitored air quality in the Central Indiana nonattainment area has shown steady decreases in fine particle levels as a result of national and local control strategies implemented since designation. In fact, the current design value for the nonattainment area is within 1 microgram per cubic meter of the standard. The design value in the area has dropped since 2001 and is predicted to continue to decline and achieve compliance with the standard in an expedient fashion.

This demonstration shows that NO_x and SO_2 emission reductions since designation have had a positive effect on regional fine particle levels. This attainment demonstration shows that once the photochemical modeling results are considered along with additional national, regional, and local control measures to be phased-in or implemented in 2008 and 2009, air quality in the area will achieve attainment of the fine particles standard by April 5, 2010 and provide for an ample margin of safety.

This plan satisfies Indiana's obligation under Section 172(c) of the CAA to demonstrate how the area will attain the air quality annual standard for fine particles by the attainment date, and, as a result, realize cleaner air. The development of this plan will bring this region into compliance with state and federal fine particle air quality standards, and provide real progress in the state's journey toward cleaner air.