CRC Report No. E-101

REVIEW OF EPA'S MOVES2014 MODEL

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Review of EPA's MOVES2014 Model

prepared for:

Coordinating Research Council

August 11, 2016

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1. EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) is responsible for developing and regularly updating the models that are used to estimate mobile source emissions for purposes of air quality planning purposes in all areas of the United States outside of California (which has authority to develop and use its own models, subject to EPA approval). In December 2009, EPA moved to an entirely new modeling platform referred to as the Motor Vehicle Emission Simulator (MOVES) model. MOVES is described by EPA as "a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics."

As noted above, the first version of MOVES (MOVES2010) was released in December 2009. Subsequently, there were two minor revisions (MOVES2010a and MOVES2010b) in which new features were added and a minor bug fixed. On October 7, 2014, MOVES2014, the first major revision to the MOVES model, was released,[1] and it must be used for all air quality planning conducted outside of California on or before October 6, 2016. As expected from a major revision, MOVES2014 differs substantially from MOVES2010. A minor revision to MOVES2014 occurred in November 2015, and the new version of the model is known as MOVES2014a.

MOVES represents a new paradigm in on-road emissions inventory modeling in that it allows the assessment of vehicle emissions at both macro- and micro-scale levels. The innovative methods that define MOVES relative to the predecessor model known as MOBILE also require a wholly new set of underlying databases and categorization schemes. Given this, the accuracy of MOVES depends in large part on the underlying data supporting these new methods, which underwent substantial revision during the development of MOVES2014 from MOVES2010.

In light of the importance of accurate assessments of mobile sources in the air quality planning process and the scope of the revisions made in developing MOVES2014, the Coordinating Research Council (CRC) undertook Project E-101 to provide an independent review of MOVES2014. The project scope included three distinct elements: (1) a critical evaluation of selected modeling methodologies, data, and assumptions; (2) analyses of emissions inventories prepared using MOVES2014 for selected cities; and (3) a comparative analysis of the impact of gasoline properties on exhaust emissions from the latest-technology vehicles from studies independent of the MOVES model development.

1.1 Critical Evaluation

This review involved a detailed examination of the model methods, data, and assumptions, focusing on areas for further improving the model. The examination resulted in a series of recommendations, the most significant of which, in terms of the potential impact on the emission inventory, addressed the following areas:

- Emission rates for heavy-duty diesel vehicles;
- Emission rates for light-duty gasoline vehicles;
- Assessment of fuel properties on emissions; and
- Assessment of impacts of inspection and maintenance (I/M) programs on light-duty vehicle emissions.

The primary findings and recommendations of the critical evaluation are summarized below.*

1.1.1 Heavy-Duty Diesel Vehicles

Two recommendations arose from the review of heavy-duty diesel vehicle emission rates. The first pertains to the potential for underestimating NOx emissions from 2010 and later model year vehicles equipped with selective catalytic reduction (SCR) systems. To address this, it is recommended that MOVES2014 be modified to account for the lowered efficiency of SCR during vehicle start-up and during other operating modes where low exhaust temperatures occur.

Second, it is recommended that changes be made to the methodology used to estimate emissions of particulate matter originating from engine crankcases on pre-2007 model year vehicles to improve their accuracy.

1.1.2 Light-Duty Gasoline Vehicles

Two recommendations resulted from the review of light-duty gasoline vehicle emission rates. The first involves suggested changes to the methodology used to estimate exhaust particulate emissions in order to improve the accuracy of estimates for vehicles equipped with gasoline direct-injection (GDI) engines, which may be understated. The second involves suggested changes to the methodology used to estimate evaporative emissions of hydrocarbons due to fuel permeation of components on vehicles designed to comply with the most stringent current evaporative emission standards, which may be overstated.

* During the course of this project, EPA released MOVES2014a, a minor update to the model. A number of the findings from the critical evaluation of MOVES2014 completed in this project were addressed by the agency. The key differences between MOVES2014 and MOVES2014a as related to the critical evaluation completed are summarized in Appendix C to this report.

1.1.3 Fuel Properties

There were a number of recommendations regarding the assessment of fuel properties. The most substantive of these addresses the use of 15% blends of ethanol and gasoline (E15) in gasoline vehicles. Although the use of E15 is not approved in older light-duty vehicles, heavy-duty vehicles, or motorcycles, this restriction is not reflected in MOVES2014. Therefore, structural modifications are recommended that would restrict the assumed E15 consumption to only those newer light-duty vehicles for which it is approved.

Another recommendation involved the methodology used to assess the impact of gasoline volatility as characterized by Reid Vapor Pressure (RVP) on exhaust emissions during winter months. At present, this impact is based on emissions data collected using fuels and test temperatures that are not representative of wintertime conditions. Therefore, it is recommended that EPA either should collect and evaluate suitable data for winter season application of this exhaust emissions adjustment factor in MOVES or should restrict the adjustment to use within the range determined by the limits of the existing available data.

Other recommendations related to fuel properties include making corrections to the tool (Fuel Wizard) used to change fuel properties from default values to improve accuracy; and reviewing and correcting, as necessary, default and historic fuel property assignments for specific geographical areas.

1.1.4 I/M Programs

There is a single, key issue identified with the development of total hydrocarbon (THC), carbon monoxide (CO), and oxides of nitrogen (NOx) exhaust emission rates for light-duty gasoline vehicles present in the default MOVES input database. The model incorrectly applies additional I/M benefits to the emission rates input for a subset of light-duty vehicles that already include the impacts of I/M. The recommended fix to the problem is to readjust both I/M and no-I/M emission rates input into the model. The unintended consequence for the impacted vehicles—1981 to 1995 model year passenger cars and light-duty trucks—is that the model is underestimating the exhaust emission rates for scenarios involving either the presence or absence of a local I/M program.

1.2 Inventory Analyses

Emission inventory analyses for THC, NOx, fine particulate ($PM_{2.5}$), and CO were performed for the three calendar years of 2011, 2022, and 2050 and three counties that reflect a wide range of ambient conditions and local fuel and I/M regulations. These counties were Fulton County, Georgia; Maricopa County, Arizona; and Wayne County, Michigan.

The most striking observation was that on-road emissions are forecast to decrease dramatically in all three areas from 2011 onward due to existing federal regulations. More specifically, the results showed the following:

- By 2022, the average decline in THC, NOx, $PM_{2.5}$, and CO emissions from 2011 under the Base Case is 55%, 71%, 73%, and 43%, respectively (i.e., the average across all three locations); and

- By 2050, the average decline in THC, NOx, $PM_{2.5}$, and CO emissions from 2011 under the Base Case is 69%, 81%, 82%, and 68%, respectively.

Compared to the Base Case reductions above, the impacts of local fuel and I/M programs evaluated as part of the sensitivity cases are less significant. Moreover, the impact of local control programs decreases over time from 2011 to 2050.

1.3 Comparative Analyses of Fuel Factor Effects in MOVES2014

One of the major updates to MOVES2014 was the incorporation of newly developed methods for estimating the impacts of gasoline parameter variation on exhaust emissions from the latest technology vehicles. These new methods addressed sulfur-content impacts and non-sulfur impacts applied to 2001 and later model year vehicles. The comparative analyses were performed to compare MOVES2014 estimates of these impacts to data from emissions testing programs that were not included in the development of the MOVES methodology as well as from other methodologies developed for the same purposes available in the literature.

The results of the comparative analyses indicate that the MOVES2014 methodology used to account for fuel property impacts other than sulfur performed equally well as other predictive models found in the literature. However, it was not possible to draw firm conclusions regarding the methodology related to sulfur impacts due to the absence of comparable vehicle test protocols among the relevant literature studies that we reviewed to assess the model methods. Notably, the MOVES model sulfur impacts are within the range of the two independent studies' results.

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2. INTRODUCTION

2.1 Problem Statement

EPA's MOVES model represents a new paradigm in on-road inventory modeling—one that allows the assessment of vehicle emissions at both macro- and micro-scale levels. The innovative methods that define MOVES relative to the predecessor model known as MOBILE also require a wholly new set of underlying databases and categorization schemes. The accuracy of MOVES depends in large part on the underlying data supporting these new methods.

The goal of Coordinating Research Council (CRC) Project E-101 is to provide an independent, comprehensive review of the MOVES2014 regulatory model, focusing on the newest technical elements developed specifically for the MOVES2014 release. MOVES2014 is the first *major* revision to MOVES. The first, official version of MOVES (MOVES2010) was released in December 2009.[*] The term "major revision" is specific, and it signifies that all policy and planning efforts in the U.S. (except California) are required to change over to the new model. For official planning purposes, the transition must occur within the two-year grace period announced on October 7, 2014.[1]

In addition, there were two *minor* revisions (MOVES2010a and MOVES2010b) in which new features were added and minor bug fixes occurred (leaving the fundamental methodology and support data intact). The term "minor" revision in this case means that for the purposes of official planning purposes the models are interchangeable. A minor revision of MOVES2014 was released (i.e., MOVES2014a) in November 2015 during the course of this project.

The difference between major and minor revisions is an important concept. In terms of continued model development by the EPA, the agency has to balance the potentially conflicting needs for "planning stability" over "methodological accuracy" when considering a minor release of the model, so as to not disrupt the planning activities already underway with MOVES2014.

The timeline for the next major revision to MOVES is dictated by policy and planning deadlines as well as federal regulatory support functions; MOVES2014 will be used for foreseeable future. MOVES2014 will be the tool used to set state and local policy decisions (e.g., fuel programs, I/M programs, etc.), and the goal of this project is to

[*] Earlier, unofficial model releases included Draft MOVES2004 and Draft MOVES2009 completed to solicit stakeholder input on preliminary MOVES modeling methods.

provide an understanding of the accuracy of those decisions that rely on the latest major release of the model.

2.2 Study Scope

The E-101 project is a thorough evaluation of the MOVES2014 model released on October 23, 2014, with default databases dated October 21, 2014.* The project scope included three distinct task elements: (1) a critical evaluation of modeling methods, (2) inventory analyses using the new model, and (3) a comparative analysis of the fuel impacts using independent data sources.

During the course of executing this project, EPA released MOVES2014a. A number of the findings from the critical evaluation of MOVES2014 were subsequently addressed by the agency in MOVES2014a. The key differences between MOVES2014 and MOVES2014a as related to the critical evaluation findings are summarized in Appendix C to this report.

The project scope gave a preferential examination of the technical elements that were newly developed for MOVES2014. In addition, in order to focus resources, some elements were explicitly excluded. The following technical elements were covered by the critical evaluation:

- Heavy-Duty Diesel Emission Rates;
- Light-Duty Gasoline Exhaust Rates;
- Light-Duty Gasoline Evaporative Rates;
- Gasoline Parameter Modeling on Exhaust;
- Fuel Formulation Data & Fuel Wizard;
- Activity Data;
- Temperature Corrections;
- Chemical Speciation; and
- Light-Duty I/M Programs.

Included in the scope is the examination of criteria pollutants as well as speciated compounds.

The following technical elements were excluded from the evaluation:

- Nonroad Sources;
- Heavy-Duty Gasoline Vehicles;
- Light-Duty Diesel Vehicles;

* MOVES2014 was originally released July 31, 2014. The October rerelease of the model was termed a "patch" by EPA in which significant corrections to non-road sources were completed. Corrections to on-road sources were qualified as "low impact" in the October release announcement (*www.epa.gov/otaq/models/moves/documents/420b14094.pdf*). This project examined the October rerelease of MOVES2014.

- Motorcycles;
- CNG Buses;
- GHG pollutants and Energy Rates; and
- Tire and Brake Wear Emission Rates.

The emission inventory analyses completed under the project scope covered all on-road sources for the criteria pollutants of THC, CO, NOx, and $PM_{2.5}$. All exhaust and evaporative emissions processes were included in the inventory assessments. PM emissions from brake and tire wear were excluded, as such PM results reported are the sum of all exhaust processes only. Inventories, for the representative locations, were calculated for the Base Case (current regulatory context) and a suite of sensitivity cases.

Lastly, the newly developed MOVES2014 gasoline parameter modeling methods were reviewed against exhaust measurements from other fuel test programs. The goal of the comparative analyses was to assess the reasonableness of the new MOVES methods for sulfur and non-sulfur fuel adjustments to exhaust emissions as observed against other study results.

2.3 Report Organization

The remainder of this report is organized as follows:

- Section 3 presents the critical evaluation of modeling methods and input data, and also documents the project's recommendations and findings;

- Section 4 presents the inventory analyses covering both the Base Case and sensitivity cases;

- Section 5 presents the comparative analyses of the new MOVES2014 sulfur and non-sulfur impacts on exhaust emissions;

- Section 6 contains a detailed list of references cited throughout the report;

- Appendix A presents additional tabulated Base Case inventory results;

- Appendix B presents additional tabulated results from the inventory analyses for the sensitivity cases; and

- Appendix C presents the assessment of the MOVES2014a release on the findings of the critical evaluation of Section 3.

2.4 Acknowledgements

We gratefully acknowledge the review and input provided by CRC members. We also acknowledge the significant assistance provided by EPA throughout the course of this project. The agency provided confirmatory checks on methods and modeling results and addressed questions related to methods that were not available in the existing MOVES2014 technical support documents (TSDs).

While EPA did make a meaningful contribution to the outcome of this project, the opinions stated in this report are solely those of the study authors.

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3. CRITICAL EVALUATION

The critical evaluation involved a detailed assessment of the methods, data, and assumptions of MOVES2014. The evaluation preferentially examined the technical elements that were newly developed or updated for MOVES2014. In addition, in order to focus resources, some elements were explicitly excluded, as described in Section 2.2. The technical elements covered by the critical evaluation are listed below; included in the scope are the examination of criteria pollutants as well as speciated compounds.

- Heavy-Duty Diesel Emission Rates
- Light-Duty Gasoline Exhaust Rates
- Light-Duty Gasoline Evaporative Rates
- Gasoline Parameter Modeling on Exhaust
- Fuel Formulation Data & Fuel Wizard
- Activity Data
- Temperature Corrections
- Chemical Speciation
- I/M Programs
- Operating Mode Functionality

The discussion herein focuses on areas for further improving the modeling methods while spending disproportionately less time on areas deemed satisfactory in the model's methods.

The result of this evaluation is a series of recommendations addressing key issues identified during the review. In a limited number of instances, we also identified "corrections" to the MOVES2014 model and supporting data. These corrections are instances where the model or underlying data did not appear to be consistent with the methods intended by the EPA.[*] In each case, our findings were provided to the EPA upon discovery for review.

Finally, it should be noted that a number of the findings from the critical evaluation of MOVES2014, as presented here in Section 3, were subsequently addressed by the agency in the release of MOVES2014a. The key differences between MOVES2014 and MOVES2014a as related to the findings of the critical evaluation can be found in Appendix C to this report.

[*] The judgment that these are indeed "corrections" to the MOVES2014 model is solely that of the study authors; EPA's opinion on whether these qualify as corrections may differ.

3.1 Heavy-Duty Diesel Emission Rates

3.1.1 Overview

This element of the evaluation examined the criteria pollutant emission rates for heavy-duty diesel vehicles in MOVES2014. New to MOVES2014 were the following:

1. Updated emission rates with data from two substantial test programs; and
2. Updated methods to address the Phase 1 heavy-duty GHG rule.[2*]

The evaluation involved an examination of the database emission rate inputs, EPA resources, and independent data sources. EPA resources included the Federal Advisory Committee Act (FACA) review material,[3,4] the MOVES2010 version of the heavy-duty emission rate documentation,[5] and EPA input. The EPA provided input on the data coverage new to MOVES2014 and the background of the crankcase methodology.[†] These were provided in the absence of the MOVES2014 heavy-duty emission rate documentation, which arrived late in the project timeline.[6]

3.1.2 Evaluation

The evaluation considered several areas, as listed and discussed below.

- SCR NOx control effectiveness
- NOx start exhaust from SCR-equipped vehicles
- Phase-in of 0.2 g/bhp-hr NOx
- Pre-2007 model year crankcase emissions
- GHG rule impacts
- Hole-filling procedures and additional data sources

SCR NOx Control Effectiveness

The emission rate inputs to the model were examined for consistency with the regulatory context for heavy-duty diesel engines and to review the emission rate data newly incorporated into MOVES2014. This review found that the SCR control effectiveness for NOx emissions was constant across all operating modes (i.e., effectively a uniform NOx conversion efficiency) beginning with model year 2010.[‡] It was confirmed that the new

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[*] The GHG rule impacts criteria pollutants in two ways. First, the reduction in energy consumption during running operation (on the order of a few percent) from engine and trailer efficiencies results in criteria pollutant reductions as emission rates are defined on a unit work basis. Second, the introduction of auxiliary power units (APUs), as an idle reduction strategy, has distinct criteria emission rates.

[†] The MOVES2010 heavy-duty emission rate documentation did not address crankcase emissions. EPA provided a draft excerpt of the MOVES2014 heavy-duty emission rate report addressing crankcase emissions methods.

[‡] For diesel vehicles above 10,000 lbs GVWR, MOVES2014 assumes 100% SCR implementation beginning with model year 2010 in order to meet the requisite 0.2 g/bhp-hr NOx standard. The NOx exhaust rates of SCR-equipped Class 8 trucks is an 89% reduction over 2006 model year NOx rates for all operating modes (for age group 0 to 3 years).

test data incorporated into MOVES2014, including model years up through 2009, did not capture any SCR-equipped vehicles. The modeling assumption of uniform control effectiveness across operating modes for SCR was carried forward from MOVES2010.

By comparison, a recent study sponsored by the South Coast Air Quality Management District (SCAQMD) examined SCR effectiveness under various driving conditions and test cycles.[7] This study, whose results were factored into the development of EMFAC2014 by the California Air Resources Board (CARB),[8] demonstrated that the NOx control effectiveness varied significantly by operation mode. Operation mode impacts the exhaust temperature, and the SCR aftertreatment system remains effective at or above 250 °C. For goods-movement vehicles, the variation in NOx emission rate—by test cycle measured—differed by an order of magnitude (Table 3-1). The SCR was observed as almost continuously operational for the six-day cross-country trip (i.e., at high sustained speeds); SCR was operational about 40% of the time for transient cycles measured (i.e., the UDDS and regional cycles); and SCR was not operational at long-duration low speeds (i.e., the "near dock" cycle).

Table 3-1
NOx Emission Rates, SCR-Equipped Diesel Goods-Movement Vehicles[a]

Operating Mode	NOx (g/bhp-hr)
Near Dock Cycle	1.79
Local Cycle	1.26
Urban Dynamometer Driving Schedule (UDDS)	0.41
Regional Cycle	0.37
Six-Day Cross-Country Trip[b]	0.16

a. Vehicles certified to a 0.20 g/bhp-hr NOx standard. Duty cycle and UDDS results represent the mean of a three-vehicle test fleet; the six-day cross-country trip result represents just one vehicle (one of the three vehicles tested).
b. Trip includes one day of high-altitude travel (Day 3); excluding Day 3, the overall NOx rate observed was 0.11 g/bhp-hr for the remaining five days.
Source: Center for Alternative Fuels, Engines, & Emissions, In-Use Emissions Testing and Demonstration of Retrofit Technology for Control of On-Road Heavy-Duty Engines, July 2014.

This modeling issue is important to ozone air quality planning because the spatial distribution of NOx control will be considerably different than the uniformly applied NOx reduction assumed by MOVES2014. The SCAQMD study indicated that stop-and-go operation and extended idling exhibited a reduced NOx conversion efficiency, and those operation characteristics are more likely to occur in urban areas or for vehicles of specific vocations (e.g., drayage trucks). Conversely, the results of the cross-country trip were reported to achieve an 83% to 88% NOx conversion efficiency of the SCR aftertreatment system.

Another observation from the six-day cross-county trip evaluated in the SCAQMD study was the presence of high-NOx events due to SCR maintenance strategies. The most significant high-NOx event was the travel on Day 3 at high altitude (daily mean altitude of approximately 8,000 feet); the mean NOx rate for Day 3 was 0.78 g/bhp-hr. MOVES2014 does not include altitude adjustments on exhaust emissions for heavy-duty diesels, and these data suggest the impact of altitude on exhaust control could be an area of further study for SCR-equipped vehicles.[*]

NOx Start Exhaust from SCR-Equipped Vehicles

Start emissions are the incremental emissions that occur (relative to the emission level observed for stabilized, running operation) from engine and control system warmup. For NOx exhaust, MOVES2014 includes a NOx start exhaust increment of 1.683 g/trip for heavy-duty diesel vehicle classes at or below 19,500 lbs GVWR and zero grams for classes above 19,500 lbs. These, reflecting a cold start, are based on limited data and are applied to all model years and vehicle ages.

MOVES2014 does not include the NOx start emissions occurring from SCR-equipped vehicles—the incremental exhaust occurring before the system is fully warmed up. CARB determined that the SCR system takes between 5 and 10 minutes to warm up over a range of conditions; during that period, CARB estimates that the NOx exhaust increment (for a cold start) is 29.80 g/trip.[8] The agency further commented during a public meeting that including the NOx start exhaust increases the overall NOx from SCR-equipped vehicles by 15 percent. [9]

The inventory impact of including NOx start exhaust from SCR-equipped vehicles, following CARB methods, was explored in the sensitivity cases presented later in this report (see Section 4).

Phase-In of 0.2 g/bhp-hr NOx Standard

The phase-in of the 0.2 g/bhp-hr NOx standard for new heavy-duty diesel vehicles is not handled consistently in MOVES2014. For new vehicle emissions, MOVES2014 assumes the regulatory phase-in for the final 0.2 g/bhp-hr NOx standard for heavy-duty diesel vehicles, which is 100% compliance commencing with the 2010 model year. This implementation schedule was confirmed by examining the NOx emission rate inputs. However, when determining an adjustment to the NOx emission rates that reflected deterioration from "tampering and malmaintenance," the EPA recognized that certain manufacturers (representing 30% of heavy-duty diesel vehicle sales in model years 2010 through 2012) were able to delay compliance with the final 0.2 g/bhp-hr standard through the use of accumulated emission credits. In the case of the NOx exhaust deterioration parameters, full implementation of the 0.2 g/bhp-hr standard does not occur until the 2013 model year.[6]

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[*] The management strategies by which a vehicle's exhaust control system are allowed to compensate for extreme conditions such as altitude, in order to not incur damage to the control system, will vary from manufacturer to manufacturer and from vehicle to vehicle.

The current MOVES2014 approach represents an inconsistency in the assumed phase-in for the 0.2 g/bhp-hr NOx standard. It would be advisable to fully integrate the delay in the 0.2-gram NOx standard throughout the development of the NOx emission rates inputs. The 30% market share delay in the NOx standard for model years 2010 to 2012 is similar to the assumption CARB used when developing NOx emission rates for EMFAC2014 (Table 3-2).

Table 3-2
EMFAC2014 Heavy-Duty Diesel NOx Standard Implementation Schedule

Model Year	NOx Certification (g/bhp-hr)		
	0.5	**0.35**	**0.2**
2010 – 2012	4.1%	24.6%	71.3%
2013 and later			100%

Source: California Air Resources Board, EMFAC2014 Volume III – Technical Documentation, v1.0.7, May 12, 2015

Pre-2007 Model Year Crankcase Emissions

Crankcase emissions, also known as blow-by, are gases that escape into the crankcase from the combustion chamber, turbocharger, or air compressor—each of which is lubricated with engine oil. The most prominent source is from the combustion chamber, with up to 40 percent of blow-by gases coming from the turbocharger and air compressor.[10]

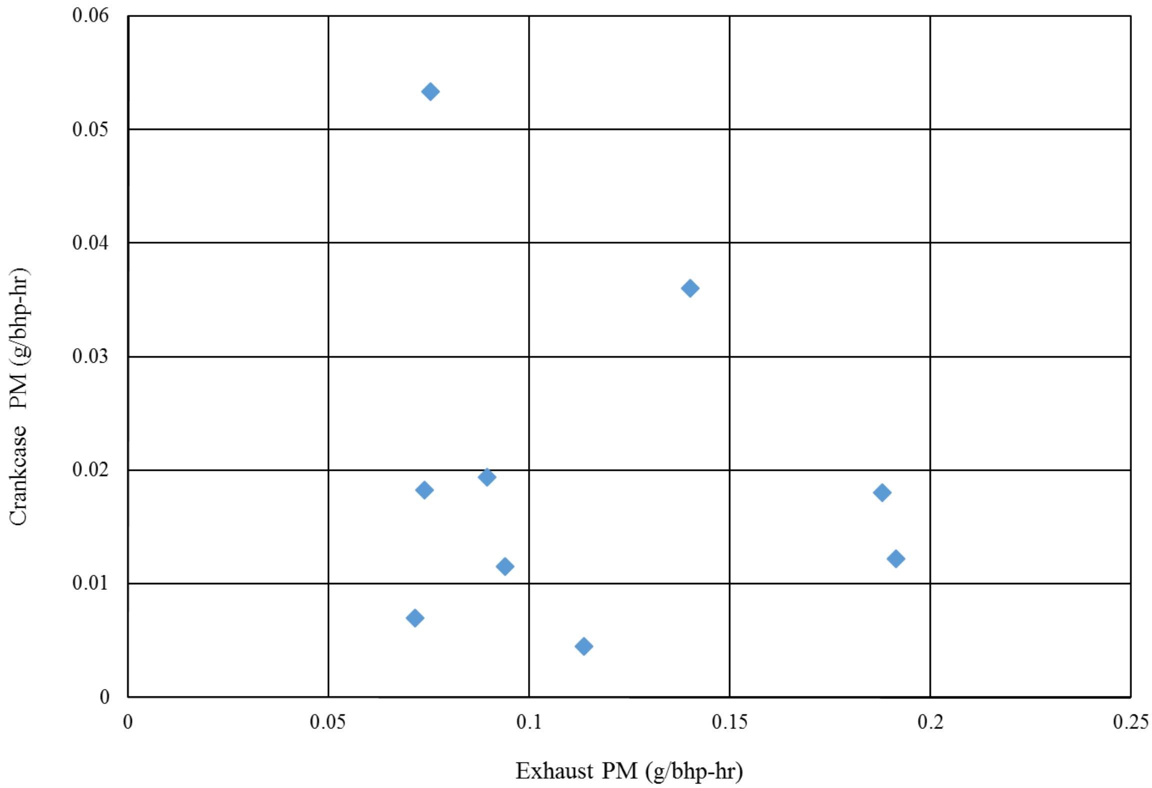
MOVES2014 models the heavy-duty diesel crankcase emissions of pre-2007 model year vehicles as a fixed fraction of tailpipe exhaust emissions (Table 3-3). The model applies those fixed fractions to start and running exhaust equally to determine both start and running crankcase emissions. For HC and CO, where the crankcase pollutants originate from fuel combustion products in the combustion chamber, modeling crankcase emissions as a fixed fraction of exhaust is a sound approach. However, this is not a technically sound method for estimating crankcase $PM_{2.5}$ emissions because these emissions originate from oil vaporization,[10,11] and there is no demonstrated relationship between tailpipe and crankcase PM emissions.

Table 3-3 MOVES2014 Crankcase/Tailpipe Ratio for Pre-2007 Model Year Heavy-Duty Diesels	
Pollutant	**Crankcase/Tailpipe Ratio**
HC	0.037
CO	0.013
NOx	0.001
$PM_{2.5}$	0.2
Source: U.S. EPA, "Exhaust Emission Rates for Heavy-Duty On-road Vehicles in MOVES2014," September 2015[6]	

It is not fully clear how the crankcase/tailpipe ratio of 0.2 for $PM_{2.5}$ (Table 3-3) was derived. The MOVES2014 HD emission rate documentation[6] presents tabulated ratios for five pre-2007 model year engines and the 0.2 PM ratio does not appear to be mathematically derived. In this evaluation, nine distinct engines were pulled from the references of the MOVES documentation (covering model years 1991 through 2006) and these data were reviewed.[10,11,12,*] The data from those engines exhibited PM crankcase/tailpipe ratios ranging from 0.04 to 0.71, with a mean value of 0.17 which is comparable to the 0.2 value reported in Table 3-3. The emission rate data for the nine engines, presented in Figure 3-1, show no relationship between crankcase and tailpipe PM emission rates.

[*] These nine engines overlap with three of five in the MOVES documentation.[6] The reference for two pre-control engines (model years 1996 and 1973) in the MOVES documentation was not identified and is not included in this review.

Figure 3-1
Crankcase PM versus Exhaust PM (g/bhp-hr)



Coupling the PM crankcase emissions to PM exhaust emissions is a problematic methodology for this model year group because many of the exhaust PM adjustment factors and trends in PM exhaust (due to changes in exhaust PM certification standards) ultimately should not factor into the model's estimates for crankcase PM. Relevant points to consider are outlined below.

1. Exhaust (tailpipe) emission rates have declined with the implementation of PM exhaust standards within the pre-2007 model year group of heavy-duty diesel vehicles, and this decline in PM exhaust results in a proportional decline in crankcase PM emissions as estimated by MOVES. There is no basis that crankcase emission rates, an uncontrolled source in this model year group, have indeed declined over this period.

2. Exhaust PM emission rates are greater at cold start than at fully warmed-up operation; conversely, the preponderance of test data show that crankcase PM emission rates are less at cold start than at fully warmed-up operation.[10,12] * MOVES models start exhaust as an incremental emission rate (the mass of emissions in excess of the warmed-up exhaust rate) and applies the same fixed-

* The one observed exception was one case of testing done at engine idle.

ratio to PM start exhaust and PM running exhaust to derive crankcase emissions. This results in the model's predicted PM crankcase emissions at startup, when the underlying crankcase data indicate that these incremental emissions do not occur. It would be an improvement if the incremental PM start crankcase emissions were eliminated in MOVES2014.*

3. The coupled approach means that age-based deterioration of PM exhaust and of PM crankcase emissions are proportionally equivalent in MOVES. The application of the tampering- and malmaintenance-based deterioration adjustments to the PM exhaust emission rates is generally not applicable to crankcase emissions. While increased oil consumption represents a condition that *may* result in both increased PM exhaust and crankcase emissions, the majority of the causes of PM exhaust deterioration (e.g., fuel injector timing, clogged air filters, etc.) will not produce a 1:1 increase in crankcase PM.

4. MOVES2014 is applying PM exhaust fuel adjustments to crankcase PM emissions when no such adjustment is required. Fuel adjustments to crankcase PM include diesel sulfur content and biodiesel content.†

It was noted in this evaluation that the impacts of diesel exhaust retrofit devices, such as particulate filters, would apply, if present, only to PM exhaust and not to PM crankcase emissions. The exhaust retrofit modeling feature of MOVES is designed appropriately (i.e., without impacting crankcase emissions). It was not confirmed whether specifically a crankcase retrofit device, such as a closed crankcase ventilation retrofit, can be modeled in MOVES2014.‡

GHG Rule Impacts

The impact of the GHG rule[2] on criteria pollutant emissions was reviewed. This rule impacts criteria pollutants in two ways. First, the reduction in energy consumption during running operation (on the order of a few percent) from engine and trailer efficiencies results in criteria pollutant reductions because emission rates are defined on a unit work basis. Second, the introduction of auxiliary power units (APUs) as an idle reduction strategy has resulted in distinct criteria pollutant emission rates.

The evaluation consisted of (1) examining the physical parameters related to fuel efficiency (vehicle mass, rolling coefficients and drag coefficients), (2) reviewing the nonroad emission factors suitable for APUs, and (3) examining the replacement of hoteling at engine idle with APU usage. Overall, there were no issues of concern identified, and both data and methods appeared to be satisfactory in terms of consistency with the rulemaking assumptions and nonroad emission factors used.

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* Theoretically, given the lower emission rate at startup relative to warmed-up operation, if one were to calculate the incremental startup rate for crankcase PM, the result would be a negative number.
† In MOVES20014, exhaust and crankcase PM decrease by about 1 percent for each percent of biodiesel contained in the fuel.
‡ The MOVES2014 defaults assume no retrofit devices in-use.

Hole-Filing Procedures and Additional Data Sources

"Hole filling" defines the process used by EPA to define emission rate inputs for cases where the underlying test data have missing operating mode bins, vehicle types, and model years. Aside from the single case of SCR NOx control effectiveness for 2010 and later model years (as elaborated above), the remaining hole-filling cases are generally based on reasonable assumptions. However, there were some limitations in the ability to review MOVES2014 model results by operating mode distribution.

The fundamental emission rate reporting basis is grams per second for running exhaust and grams per trip for start exhaust. Emission rates are binned by operating mode, as described below.

1. For running exhaust, operating mode bins are defined for three speed ranges (under 25, 25-50, and over 50 MPH) and for ranges of estimated Scaled Tractive Power (STP)—a scaled measure of work completed. MOVES2014 has 23 operating mode bins defined for running exhaust.

2. For start exhaust, operating mode bins define the soak period between trips. MOVES2014 has eight operating mode bins (i.e., soak periods) defined for start exhaust.

The hole-filling process is required for operating modes not found in the underlying data (e.g., running exhaust Operation Mode ID = 40, which is the highest-speed, highest-work bin). MOVES2014 no longer reports in its output databases the operating mode distribution of the scenario under evaluation.[*] The inability to obtain an operating mode distribution out of MOVES2014 hindered the ability to discern whether the bin filling by operating mode was significant. It is inherently valuable to know the time-based frequency of operation by operation mode bin, and that information is no longer available in MOVES2014. This issue is discussed more under the topic operating mode functionality (see Section 3.10).

The Peer Reviews of both the MOVES2010 and MOVES2014 heavy-duty emission rate documents provided additional sources of emission rate data that have not been incorporated into MOVES2014.[5,6] While these data sets are generally smaller than what is already in MOVES, they may support additional emission rates and eliminate some of the hole-filling necessitated by the underlying approach.[†]

[*] MOVES2010 allowed for the extraction of the operating mode distribution in the MOVES Execution database. In MOVES2014, the operated mode reported is only for each calculation bundle (the data are not saved between bundles) and the output provided is incomplete and unusable.

[†] While there are more data sources available and more data would certainly improve the reliability of the model, it should be understood that MOVES2014 contains the most robust set of in-use exhaust data from heavy-duty diesel vehicles ever incorporated into an EPA on-road emission rate or emission inventory model.

3.1.3 Recommendations

Four recommendations result from the heavy-duty diesel emission rate evaluation; there were no corrections identified for this evaluation element.

The first recommendation is to incorporate NOx start emissions from SCR-equipped vehicles into MOVES2014. These are the emissions occurring before the control system is fully warmed up, and these are not accounted for currently. There are sufficient preexisting data to estimate this impact. Adding the incremental NOx emissions, as described in Section 4 of this report, indicates that the impact on the total on-road inventory of a fully phased-in fleet is between 5 and 20 percent (depending on local fleet inputs and season).

The second recommendation is to improve the modeling of SCR control effectiveness to address the variation in effectiveness by operation mode or roadway type (e.g., urban versus rural). SCR control effectiveness in MOVES2014 is applied uniformly across all running exhaust operation modes. Recent in-use testing of SCR-equipped vehicles indicates that maintaining the SCR control system's optimum operating temperature significantly depends on duty-cycle (i.e., operating conditions). The result is that SCR control effectiveness varies, with the greatest effectiveness observed at sustained high speeds (e.g., rural interstate operation) and the least effectiveness at the slowest speeds (e.g., congested urban driving). As such, the spatial distribution of NOx control will differ from what is assumed in MOVES2014, and characterizing this represents a significant challenge in subsequent model development.

The third recommendation is to revise the method used to estimate crankcase PM emissions from pre-2007 model year vehicles. The MOVES2014 modeling of crankcase emissions as a fixed fraction of tailpipe exhaust emissions, reasonable for most pollutants, is not technically suitable for the PM emissions because crankcase emissions originate from oil vaporization. Many of the factors applied in the MOVES model to PM exhaust should not be applied to PM crankcase emissions as is being currently done in the model. An alternative approach would be to model PM crankcase emissions as a standalone emission rate for this model year group. Fuel corrections (developed for PM exhaust) should not be applied; PM crankcase emissions at startup need to be eliminated from the model, as there are no incremental crankcase PM emissions at startup. The inventory analyses completed for this project (as reported in Section 4) indicate that pre-2007 model year crankcase emissions represent between 11 and 17 percent of the total on-road $PM_{2.5}$ inventory in the Base Case inventories estimated for 2011.

The fourth recommendation is to fully integrate the delay in the 0.2-gram NOx standard throughout the development of the NOx emission rates inputs. While the regulatory standard required full implementation beginning with the 2010 model year, manufacturers representing approximately 30 percent of sales between the 2010 and 2012 model years were able to delay their compliance with the final heavy-duty engine NOx standard by relying on certification carryover credits.

3.2 Light-Duty Gasoline Exhaust Rates

3.2.1 Overview

This element of the evaluation examined the criteria pollutant emission rates for light-duty gasoline vehicles in MOVES2014. The primary update to MOVES2014 was the creation of emission rates reflecting the recently enacted Tier 3 rulemaking.[13] In this major update to MOVES, no new underlying emission rate data were incorporated into the model for modeling light-duty gasoline vehicle exhaust. The Tier 2 baseline was left essentially unchanged from MOVES2010, and Tier 3 emission rates were defined from suitable Tier 2 certification bins with adjustments to account for differences in certification fuels and other program requirements specific to Tier 3.

The evaluation covered an examination of the database emission rate inputs, EPA resources, and independent data sources. EPA resources included the material from the Tier 3 rulemaking,[14,15] the MOVES2010 version of the light-duty emission rate documentation,[16] and EPA input. The EPA provided input to verify data and methods in the absence of the MOVES2014 light-duty emission rate documentation, which arrived late in the project timeline.[17]

3.2.2 Evaluation

The evaluation considered several areas, as listed and discussed below.

- Hole-filling procedures and future updates to the emission rate data
- Exhaust PM emission rates for GDI engines
- Tier 3 emission rate review
- Emission rate validation and operating mode distributions

Hole-Filling Procedures and Future Updates to the Emission Rate Data

It is notable that there were no new light-duty gasoline exhaust emission rate data incorporated into MOVES2014. The emission rate data developed for MOVES2010 continue to serve as the data resource supporting exhaust rates, while new assumptions were incorporated to account for the Tier 3 regulatory case update for MOVES2014.

It will be important that future updates to the exhaust emission rate data be comprehensive, representative, and have fewer individual components than that which characterizes the current exhaust method (as enumerated below). The current underlying exhaust approach (and supporting data record) is fragmented, and significant hole-filling procedures are used to fill in data gaps.* While our assessment is that the method fundamentals and hole-filling procedures are generally sound, the amount of hole filling required increases the uncertainty of the light-duty gasoline exhaust method. The

* "Hole filling" refers to the process used by EPA to define emission rates inputs for those instances where the underlying test data has missing operating mode bins, vehicle age bins, and model years.

individual components of supporting exhaust data inputs to MOVES2014 are outlined below.[17]

1. Modal running exhaust data for HC, CO, and NOx at the lower-power operating modes (i.e., the range of power covered by the FTP) are supported by second-by-second Arizona I/M data for model years 1981 through 2000 (covering vehicles up to 10 years of age within each model year).[*] Hole-filling procedures are used to fill in the remaining ages not covered by the 10-year period. Hole-filling procedures, supported by FTP data from the In-Use Verification Program (IUVP) data for model years 2001 through 2007, are used to extrapolate rates forward through Tier 2 standards.[†] Tier 3 standards are handled by interpolation from the nearest the Tier 2 bin rates.

2. Modal running exhaust data for HC, CO, and NOx at the higher-power operating modes (i.e., the power ranges above those of the FTP) are supported by the EPA's Mobile Source Observation Database records for second-by-second tests of US06 and MEC test cycles covering model years 1980 to 1999. Multiple approaches are used to define modal rates, including using test data directly and using a ratio technique defined relative to modes covered by the I/M data record.[‡] Hole-filling procedures, supported by US06 test results from the IUVP for model years 2001 through 2007, are used to extrapolate rates forward through Tier 2 standards.[†] Tier 3 standards are handled by interpolation from the nearest Tier 2 bin rates.

3. The data and rates of items (1) and (2) above define running exhaust emission rates for HC, CO, and NOx under the reference I/M case (i.e., the Arizona I/M program). The running exhaust emission rates for the no-I/M case are estimated by the percent change in emissions due to I/M (resolved by test type) in the reference I/M program.[§] I/M program running exhaust benefits are applied uniformly across all operating modes.

4. Start exhaust emission rates for HC, CO, and NOx—defined as a cold start in grams per trip—for new vehicles are calculated using the EPA's Mobile Source Observation Database for model years prior to 1996 and the IUVP for model years 1996 through 2007. The start emission rates are converted to modal rates by the application of normalized soak distribution effects obtained from MOBILE6.[**]

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[*] Modal running exhaust emission rates (i.e., by operating mode), in units of grams per second, are defined by speed bin (below 25, 25-50 and above 50 MPH) and by vehicle specific power (VSP) bin. There are 23 operating modes defined for running exhaust.

[†] For the 2001 and later model year extrapolation, EPA derived logarithmic deterioration slopes for Tier 1 vehicles (MY 1996-98) and applied them to NLEV and Tier 2 vehicles; this deterioration rate was proportionally uniform for operating modes (lower and higher power ranges).

[‡] Considerable uncertainty was observed by EPA in evaluating rates for the higher power operating modes based on the approach taken.

[§] I/M program benefits were determined from a set of first-time I/M vehicles—a set of vehicles that had migrated to the Arizona I/M region from other non-I/M areas of the US.

[**] For start exhaust, operating mode bins define the soak period between trips. MOVES2014 has eight operating mode bins (i.e., soak periods) defined for start exhaust.

Age-based deterioration rates for start exhaust for HC and CO are calculated from the running exhaust deterioration and the application of a derived ratio of start-to-running exhaust deterioration based on the IUVP data; age-based deterioration of start exhaust NOx is assumed to be proportionately equivalent to deterioration of running exhaust NOx. Tier 3 standards are handled by interpolation from the nearest the Tier 2 bin rates.

5. The development of PM exhaust rate inputs begins with composite PM test data compiled from 11 studies, including the comprehensive 2005 Kansas City test program.[18*] The 1975 to 2005 model year test data are exponentially regressed against model year to determine an exponential trend by model year. The exponential trend is applied to the 1975-2005 model year emission rates to determine age 0 vehicle composite PM exhaust rates for these model years; light-duty gasoline PM emission rates are constant starting with model year 2005 going forward until the implementation of Tier 3 standards. Data from the Kansas City test program are used to define multiple ratios to cover data gaps and convert rates to running and start exhaust for cars and trucks separately.[†] Exhaust deterioration as a function of age is also derived from the Kansas City data. Start exhaust rates, at cold start, are converted to modal PM start rates using the normalized MOBILE6 soak distribution for HC (as noted above for HC running exhaust). Running PM exhaust rates are converted to modal emission rates by operating mode using a surrogate method developed as part of the Kansas City study. Tier 3 standards are handled by applying a reduction in PM exhaust from the Tier 2 rates based on the more stringent Tier 3 PM exhaust standard.

The number of processing steps and adjustments to create light-duty exhaust emission rate coverage for all operating modes and model years is significant. Areas of uncertainty are outlined below.

1. The primary source of representative, independent data is the random data record from the Arizona I/M program. Deterioration of the light-duty gasoline vehicle exhaust as a function of age is effectively established from these data collected over a 10-year period. The deterioration of running exhaust (HC, CO, and NOx) for 2001 and later model years is derived from the Tier 1 certified vehicles within these data. The deterioration of start exhaust (HC, CO, and NOx) is directly derived from these data given the adjustment ratio approach applied. The deterioration of PM running exhaust comes from the HC running exhaust deterioration, which is derived from the Arizona I/M data. Thus much of the exhaust modeling accuracy depends on the representativeness of the deterioration observed from this one source.

[*] There is a difference between MOVES2010 and MOVES2014 PM emission rates in that data from the Kansas City test program were updated to remove an apparent silicon contamination. The PM emission rate method for MOVES2014 was then recalculated using the corrected data.
[†] Ratios define the truck-to-car PM ratio, running-to-composite PM ratio and start-to-composite PM ratio.

2. The deterioration of start exhaust may not be well handled in the current approach. According to EPA, "the most accurate means of quantifying emissions from vehicles over time is to conduct a longitudinal study, where emissions are measured for the same vehicles over several (or many) years."[17] The use of the adjustment ratio approach to scale deterioration from that observed for running exhaust (based on the IUVP data) is not equivalent to a longitudinal study of the deterioration rate of start exhaust.[*] Other comments on the ratio approach employed include (1) the agency's analysis of IUVP NMOG records is used to develop ratios applied to both THC and CO start exhaust emission rate development, (2) exhaust NOx relative ratios were assigned unity (i.e., equal start and running exhaust deterioration rates), (3) the IUVP-based ratios are applied to older model year vehicles (pre-1996 model year) not represented by the manufacturer IUVPs and (4) the I/M status of IUVP recruited vehicles is not known. Given that start exhaust is an increasingly larger share of overall exhaust emissions for Tier 2 and Tier 3 vehicles (as shown in the inventory analyses of Section 4), a direct assessment of start exhaust deterioration should be considered for future research.

3. Start exhaust deterioration is modeled by an adjustment ratio approach (as noted above) that scales deterioration from that observed for running exhaust. The same adjustment ratio is applied in the development of MOVES2014 emission rate inputs for both the I/M and no-I/M cases. Because the no-I/M case has more running exhaust deterioration (relative to the I/M case), then in the application of the ratio approach, the resulting no-I/M case also has more start exhaust deterioration (relative to the I/M case). As a consequence, when modeling I/M in MOVES, there is a reduction in both running and start exhaust emissions relative to the equivalent no-I/M case. While the running exhaust reduction due to I/M is directly derived from the EPA assessment of the reference I/M program benefit,[17] the start exhaust reduction produced by the model is not directly derived from an I/M program evaluation. The start exhaust benefit is merely a mathematical artifact of the adjustment ratio method for start deterioration, and the resulting start exhaust benefit attributed to I/M is highly uncertain. This issue is discussed further in Section 3.9 (evaluation of I/M programs).

4. Gasoline direct injection (GDI) engines, introduced with the 2007 model year and increasing in market share thereafter, have significantly distinct fuel delivery mechanics, air-fuel management strategies and combustion characteristics. The variation in emissions by operation mode of the current exhaust approach, based on conventional fuel injection engines, may not be representative of GDI engines.

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[*] Deterioration from the IUVP is not based on matched vehicles and the portion of the useful life captured in the EPA analysis appears relatively new—up through 80,000 accumulated miles based on the figures presented in the emission rate documentation (Reference 17).

Exhaust PM Emission Rates for GDI Engines

GDI engines are being introduced into the fleet due to the increased fuel efficiency associated with the technology (i.e., to meet fuel economy targets). Significant market share of GDI engines is noted beginning with the 2007 model year, and by the 2017 model year, CARB forecasts that 70 percent of light-duty gasoline engines sold will be GDI technology.[8] GDI involves high pressure fuel directly injected into the combustion chamber, which may also be coupled with turbocharging, and has distinct combustion characteristics, including an increase in PM exhaust (relative to a conventional fuel-injection gasoline engine).

MOVES2014 did not incorporate any new Tier 2 vehicle test data or modeling assumptions into the underlying PM exhaust emission rates (relative to those rates developed for MOVES2010),[*] and the baseline Tier 2 PM emission rates do not factor in the introduction of GDI engines (Tier 2 PM exhaust rates, beginning with the 2005 model year, are uniform in MOVES2014). Table 3-4 presents PM exhaust emission rates for Tier 2 vehicles from several references, including those from MOVES2014 and EMFAC2014. These data show a significant distinction between Tier 2 port fuel-injected (PFI) and Tier 2 GDI PM emission rates.

Table 3-4
PM Exhaust Emission Rates from Selected Tier 2 Light-Duty Gasoline Vehicles

Reference	Vehicles	Average Odometer	PM Exhaust (FTP Composite, mg/mi)
MOVES2014[17]	Tier 2 Baseline, PC	N/A	2.53
	Tier 2 Baseline, LDT	N/A	2.61
EMFAC2014[8]	Tier 2 Baseline, PFI	N/A	0.5
	Tier 2 Baseline, GDI	N/A	4.0
EPA Light-Duty Vehicle PM Test Program[19]	13 PFI vehicles	88,205	0.39
	3 GDI vehicles	111,668	4.81
CRC E-94-1a[20]	3 GDI vehicles, multiple fuels	7,747	5.77
Note: The certification standards for Tier 2 PM exhaust is 10 mg/mi, FTP composite.			

[*] MOVES2014 corrected the MOVES2010 Tier 2 baseline for silicon contamination initially included in the Kansas City test program results but otherwise left the Tier 2 PM emission rates unchanged from MOVES2010.

Tier 3 Emission Rate Review

A review of the derivation of the Tier 3 emission rates for MOVES2014 was completed covering the tasks outlined below.

1. The approach to developing Tier 3 exhaust rates for HC, CO, and NOx from Tier 2 Bin 2 and Tier 2 Bin 3 assumed emission rates was found to be consistent with the change in regulatory standards.

2. The calculation of the Tier 3 exhaust rates for PM showed a 50 percent compliance margin (at age=0) and effectively hitting the in-use standard of 3 mg/mile at the age (corresponding to the 150,000-mile useful life) following the deterioration rate assumption. There is an additional reduction to a 1 mg/mile exhaust standard beginning phase-in with the 2024 model year for emission rates applicable to California and Section 177 states.

3. The adjustment for Tier 3 emission rates to account for the differences in certification fuel (from Tier 2) was checked and found to be reasonable.

4. The adjustment for the increase in useful life from 120,000 to 150,000 miles was factored into the exhaust emission rates deterioration method and the method was confirmed.

Emission Rate Validation, Operating Mode Distributions

During the evaluation we wanted to apply MOVES2014 to emulate standard test cycles (e.g., the FTP) to validate the model output against independent references that report emission rates based on these test cycles. However, we found that this type of analysis of modeling a customized operating mode distribution was not supported in MOVES2014 as it was in MOVES2010. In particular, customizing the operating mode distribution as a user input cannot be easily accommodated, and new limitations on distribution reporting prevented the ability to check any method implemented.[*] These and other issues related to operating mode functionality are discussed further in Section 3.10.

3.2.3 Recommendations

The single recommendation resulting from the light-duty gasoline emission rate evaluation is that the Tier 2 baseline PM emission rates be reviewed to account for the significant impact of PM exhaust emissions from GDI engines. The emission rates of Tier 2 GDI engines appear to exceed the currently assumed Tier 2 baseline of MOVES2014 by a significant amount. In addition, PM exhaust from conventional PFI Tier 2 vehicles may be significantly less than the current Tier 2 baseline. Both the EPA and CARB completed testing of GDI Tier 2 vehicles for the Tier 3 and LEV III rulemaking efforts. Those data

[*] Ultimately, EPA disclosed that MOVES2014 will accommodate user specified operating mode distributions when used in "Project Mode" – designed for microscale hot spot/intersection analysis. This information came too late in the project timeline to be used for emission rate validation purposes.

resources need to be incorporated into the light-duty gasoline vehicle exhaust methods, and a revised modeling approach is recommended that has distinct rates by GDI and PFI technology as well as estimated model year sales of those technologies.

3.3 Light-Duty Gasoline Evaporative Rates

3.3.1 Overview

This element of the evaluation examined the THC evaporative emission rates for light-duty gasoline vehicles in MOVES2014. There were several updates to the MOVES2014 methods:

1. New methods to address multiday cold soak periods (commonly known as multi-day diurnals);
2. New data and methods to model vapor leaks from canisters;
3. Updates to temperature, RVP, and altitude adjustments to vapor generation,
4. Development of Tier 3 emission rates; and
5. Correction of a programming bug in MOVES2010 that overstated the vapor generation calculations.

The evaluation covered an examination of the database emission rate inputs, EPA resources, and independent data sources. EPA resources included the MOVES2014 methodology document for evaporative emissions,[21] additional EPA background documentation,[22,23] and EPA input.

3.3.2 Evaluation

The evaluation considered several areas, as listed and discussed below.

- Modal evaporative emissions processes
- Federal regulatory standards phase-in
- California emission standards
- Permeation rates for near-zero and zero evaporative standards
- Tier 3 emission rate review

Modal Evaporative Emissions Processes

MOVES differs from other models (i.e., EMFAC and MOBILE) in that it models the individual underlying physical processes involved in the evaporation of fuels from on-road vehicles. The MOVES2014 modeling method is distinct for the four processes summarized in Table 3-5; within each process (other than refueling), vapor emissions are modeled separately for the three modes of (1) engine operation, (2) hot soak, and (3) cold soak.[*] The modal evaporative emission rate method, unique to MOVES, is supported by data collected under several CRC sponsored studies as well as other resources.[17]

Table 3-5
MOVES2014 Evaporative Emissions Processes

Evaporative Process	Description
Permeation	Migration of hydrocarbons through materials in the fuel system
Tank Vapor Venting (TVV)	Vapor generated from the fuel system not contained by the evaporative control system (i.e., the canister)
Liquid Fuel Leaks	Liquid fuel leaking from the fuel system ultimately evaporating
Refueling	Spillage and vapor displacement from vehicle refueling

For example, the hot soak mode in MOVES is defined as the time period starting from the end of a vehicle trip to the time at which the fuel tank temperature reaches the ambient temperature. MOVES individually models vapor emissions for permeation, tank vapor venting (TVV), and liquid fuel leaks occurring during the hot soak mode. This example is fundamentally different from a certification *hot soak test* in which the evaporative emissions are measured immediately following a vehicle trip for a specified time period (e.g., one hour); this test measures emissions that are the collective sum of all three processes (permeation, TVV, and liquid fuel leaks).

Integral to the MOVES2014 model (as compared to the predecessor model, MOVES2010) are new methods used to estimate TVV emissions—in particular, the effectiveness of the canister to trap fuel tank vapor emissions. Key elements are outlined below.

1. A separate model (commonly known by the acronym “DELTA”) was originally developed by EPA for estimating TVV emissions during the cold soak mode—evaluating multi-day diurnals which were not previously addressed by MOVES2010—as part of the Tier 3 regulatory development process.[22] Ultimately, a form of the algorithms from the DELTA model was incorporated into MOVES2014. These algorithms model tank vapor generation (TVG) and the interaction with the canister to estimate the quantity of breakthrough emissions (i.e., vapor losses to the atmosphere or TVV).

[*] Refueling emissions are not mode specific.

2. The MOVES2014 methods address TVV coming from vapor leaks in the fuel system (e.g., canister, fuel tank cap) by defining vapor leak emission rates and leak frequencies by model year group and age. The emissions are modeled separately from canister breakthrough emissions. The modeling parameters for vapor leaking vehicles were defined by data obtained through portable SHED (i.e., PSHED) field studies. Key assumptions were employed to incorporate these PSHED measurements into the MOVES modal methodology.[24] [*]

An advantage of the modal methodology of MOVES is that it specifically and separately addresses each of the individual physical phenomena producing evaporative emissions. The methodology represents a distinct achievement in evaporative emissions modeling. Our review of the DELTA model and the new components to MOVES2014 found all the updates to be significant improvements over the MOVES2010 approach. The primary challenge in moving forward will remain obtaining additional data necessary to support the model's innovative evaporative methods. EPA has an on-going effort to evaluate and improve the underlying evaporative emissions data for MOVES. One issue being investigated by EPA that is germane to this effort is improving the ability to model canister degradation, which implies that the model's TVV estimates may be too low. [25] EPA also cites ambient studies that suggest an overall underestimation of evaporative emissions from vehicles (while soaking).[26]

Federal Regulatory Standards Phase-In

The engineering of vehicle evaporative control systems has occurred as certification standards (and underlying test procedures) evolved. Table 3-6 summarizes the U.S. federal evaporative certification standards from uncontrolled to future Tier 3 standards. Table 3-6 reports information specific to gasoline-powered passenger cars; numeric test standards and model year applicability differ for other regulatory vehicle classes (e.g., light-duty trucks).

[*] These assumptions are as follows: (1) any vehicle exceeding 0.3 grams in a 15-minute hot soak test was classified as leaking vapor regardless of certification standard; (2) permeation emissions were assumed to be negligible (hereby double counting a presumed insignificant level permeation from the vehicle); and (3) any vehicle exceeding 15 grams in a 15-minute hot soak test was classified as a liquid fuel leaker and eliminated from the analysis of vapor leaking vehicles.

Table 3-6
US Federal Evaporative Certification Standards, Gasoline Passenger Cars

Certification Regime	Model Years	Phase-In	Diurnal & Hot Soak Standard	Additional Standards
Uncontrolled	1970 and earlier	N/A	N/A	N/A
Early Control, Carbon Trap	1971 - 1977	No	6 g/test (1971) 2 g/test (1972-1977)	N/A
Early Control, SHED	1978 - 1998	No	6 g/test (1978-1980) 2 g/test (1981-1998)	N/A
Enhanced Evaporative	1996 - 2006	Yes	2 g/test[a]	0.05 g/mi Running Loss 0.2 g/gal Refueling
Tier 2 Evaporative	2004 - 2021	Yes	0.95 g/test (2004-2008)[a] 0.50 g/test (2009-2021)[a]	0.05 g/mi Running Loss 0.2 g/gal Refueling
Tier 3 Evaporative	2016 and later	Yes	0.30 g/test[b]	0.05 g/mi Running Loss 0.2 g/gal Refueling 0.02 g/test Canister Bleed

a. Includes worst day of 3-day diurnal test.
b. Includes worst day over either 3-day or 2-day diurnal tests.

The pertinent details related to the federal certification standards (Table 3-6) are outlined below.

- The testing protocols for Early Control (Carbon Trap), Early Control (SHED), and Enhanced Evaporative are all significantly different such that the 2 and 6 gram standards between certification regimes are not directly comparable.

- Tier 2 Evaporative – The certification standard for the primary track (i.e., 3-day diurnal) was reduced to 0.95 g/test under a worst-case fuel assumption (i.e., a 10 percent ethanol blend) for 2004 model year passenger cars. This Tier 2 evaporative standard is also commonly known as the “near-zero” evaporative standard. Both EPA and CARB promulgated harmonized evaporative test procedures commencing with the 2009 model year, after which the applicable three-day diurnal Tier 2 standard is 0.5 grams. The 2009 model year revised standard is not considered a change in stringency; the underlying fuel and temperature stipulations for the 0.95 and 0.5 gram/test standards differ and the numeric values are not directly comparable.

- Tier 3 Evaporative – The Tier 3 diurnal plus hot soak standard of 0.3 grams includes the worst case 24-hour diurnal measured over either the three-day or two-day diurnal tests. This standard is commonly known as the "zero" evaporative standard as it is largely a derivative of the CARB evaporative standard applicable to partial zero emission vehicles (PZEVs) defined as part of the California LEV II program.[*] A canister bleed procedure and accompanying standard were added for Tier 3.

The development of MOVES2014 emission rates by model year group and the assignment to federal certification standards assumed by the model is summarized in Table 3-7. Comparing the MOVES2014 regulatory implementation assumption with the federal regulatory case (Table 3-6) indicates some key differences assumed by the model in terms of modeling the federal regulatory context of evaporative emissions.

Table 3-7
MOVES2014 Model Year Grouping and Assignment to Certification Standards

Model Year Group	Evaporative Emission Standard
1971-1977	Pre-control
1978-1995	Early control
1996	80% early control; 20% enhanced evaporative
1997	80% early control; 20% enhanced evaporative
1998	80% early control; 20% enhanced evaporative
1999-2003	Enhanced evaporative
2004-2015	Tier 2 evaporative
2016-2017	40% Tier 3
2018-2019	60% Tier 3
2020-2021	80% Tier 3
2022+	Tier 3

Source: "Evaporative Emissions from On-Road Vehicles in MOVES2014," EPA-420-R-14-014, U.S. Environmental Protection Agency, 2014.

Outlined below are key distinctions where the MOVES2014 regulatory implementation assumptions differ from the actual regulatory requirements.

- The pre-control group (1971 to 1977 model years) is not technically pre-control. There are canisters within this model year group that were subject to carbon trap standards. This is an issue of title only. MOVES2014 does not include any pre-control evaporative emission rates.

[*] "Preliminary Discussion Paper – Amendments to California's Low-Emission Vehicle Regulations for Criteria Pollutants – LEV III," State of California, Air Resources Board, February 2010.

- The vehicles within pre-control and early control groups are not uniform in standards. There are separate 6 and 2 gram standards within each, depending on model year (see Table 3-6).

- The enhanced evaporative phase-in assumed in model years 1996 through 1999 is specific to the passenger car regulatory case. However, MOVES applies this implementation schedule to all light-duty and heavy-duty gasoline vehicles except motorcycles.

- The regulatory phase-in of the Tier 2 evaporative requirements assumes 100 percent compliance with the 2004 model year; it is not clear if this is an over-simplification or if the agency believes that manufacturers actually achieved this early compliance with Tier 2 evaporative standards.

- Actual enhanced evaporative and Tier 2 evaporative phase-ins will be different from those assumed (influenced by manufacturer safety margin and synergies with similar California phase-in requirements). And regulatory phase-ins should be replaced by actual data when available. Regulatory implementation schedules would need to be defined separately for passenger cars and light-trucks (and current model assumptions have a single implementation schedule for all gasoline vehicles, except motorcycles).

California Emission Standards

Table 3-8 summarizes the California evaporative certification standards from early control SHED to LEV III evaporative standards for gasoline-powered passenger cars; standards prior to the 1978 model are the U.S. federal standards shown in Table 3-6.

Table 3-8
California Evaporative Certification Standards, Gasoline Passenger Cars

Certification Regime	Model Years	Phase-In	Diurnal & Hot Soak Standard	Additional Standards
Early Control, SHED	1978 - 1998	No	6 g/test (1978-1979) 2 g/test (1980-1998)	N/A
Enhanced Evaporative	1995 - 2005	Yes	2 g/test[a]	0.05 g/mi Running Loss 0.2 g/gal Refueling
LEV II Evaporative	2004 - 2021	Yes	0.50 g/test (Near Zero)[a] 0.35 g/test (Zero)[a]	0.05 g/mi Running Loss 0.2 g/gal Refueling
LEV III Evaporative	2015 and later	Yes	0.30 g/test (Option 2)[b]	0.05 g/mi Running Loss 0.2 g/gal Refueling 0.02 g/test Canister Bleed

a. Includes worst day of 3-day diurnal test.
b. Includes worst day over either 3-day or 2-day diurnal tests; Option 1 standard is 0.35 g/test without separate canister bleed test but including a 0.054 g/test fuel system requirement.

There is considerable overlap in California and US federal evaporative certification standards and procedures. With that understood, distinctions in the California requirements, which differ from the federal case, are outlined below.

- Start model year and phase-in schedules are specific to California (i.e., California started the 2-gram early control SHED and 2 gram enhanced evaporative standards one model year earlier than the federal requirement).

- Starting with enhanced evaporative standards, the diurnal temperature range is distinct (72°-96°F for federal and 65°-105°F for California).

- Certification fuel is summer-season California cleaner-burning gasoline (lower RVP than federal certification fuel); ethanol-containing certification fuel (i.e., E10) is not required until LEV III standards.

- For LEV II standards, a portion of the fleet is certified to the "zero" evaporative standard to comply with the ZEV requirements specific to the California on-road emissions program. E.g., this standard is required to be met by partial zero emission vehicles or PZEVs.

Testing by EPA showed the high RVP/low temperature of the federal procedure was equivalent to the low RVP/high temperature of the California procedure and EPA therefore accepted either procedure for certification. By and large, a preponderance of vehicles are certified to both federal and CARB requirements; these are termed "50-state vehicles." These represent instances where California and federal certification standards may differ technically but the actual evaporative control systems of vehicles are identical nationally. This represents an important context for setting the regulatory assumptions of federal standards in MOVES2014.

Solely accounting for the federal regulatory standards of the vehicle fleet may not capture the range of evaporative control systems in-use in the federal certification region. There may be vehicles (e.g., PZEVs) that certified to the California LEV II zero evaporative standard that were also certified federally (e.g., a 50-state vehicle certified to California's LEV II zero evaporative standard). As a result, an unknown proportion of the federally certified Tier 2 light-duty fleet meets California's LEV II zero evaporative standard.[*] This represents a regulatory case that should be evaluated for significance in future model development.

[*] It was not within the scope of this project to identify the proportion of the Tier 2 light-duty fleet meeting the California LEV II zero evaporative standard. CARB, for example, estimates that a majority of the 2011 model year passenger car sales (59.1 percent) were certified to the zero evaporative standard in the development of EMFAC2014 evaporative emission rates. Manufacturers would decide, on a case-by-case basis, whether the economics favored developing/equipping separate hardware for meeting the Tier 2 evaporative standard for federal certification or keeping the same hardware for both California and federal certification requirements.

Permeation Rates for Tier 2 & LEV II Evaporative Standards

It was determined that the MOVES2014 underlying data for permeation emission rates omit key recent test data and significantly over-estimate permeation from Tier 2 certified vehicles (i.e., near-zero standards). The MOVES2014 evaporative technical support document indicates that permeation emission rates are based on CRC E-9 and E-41 test programs with test data through the 1997 model year; the model applies the enhanced evaporative permeation rates to Tier 2 vehicles without modification. The document further states that "recent data from the E-65 and E-77 programs were not significantly different from the previous findings and served to validate the MOVES Tier 2 permeation base rates."[21] The MOVES2014 base permeation rate (for ethanol free gasoline at 72 degrees) and ethanol-blend adjustment applied to 1999 through 2015 model year vehicles are shown in Table 3-9.

Table 3-9
MOVES2014 Base Permeation Rate for Enhanced Evaporative and Tier 2 Vehicles

Parameter	Value
E0 Base Permeation Rate at 72 ^{o}F (g/hr)	0.0102
Permeation Increment for Ethanol-Blend Gasoline	+113.8%

For this evaluation, we reviewed a combined database of the CRC E-65,[27,28] CRC E-77,[29,30,31,32] and EPA Multiday Diurnal[33] test programs and calculated the permeation rates and ethanol impacts reported in Table 3-10.[*] The results for enhanced evaporative vehicles are quite similar to those results used by MOVES2014 (Table 3-9); these data demonstrate a remarkable consistency between these studies for the enhanced evaporative certification standard and those rates used by MOVES2014. The permeation rates for near-zero and zero evaporative vehicles, however, are significantly less than those for enhanced evaporative vehicles. Moreover, vehicles meeting the near-zero and zero evaporative standard were also found to be less sensitive to the increase in permeation due to ethanol.

[*] The database encompassed 17, 12, and 5 unique vehicles for the enhanced, near-zero, and zero evaporative standards, respectively.

Table 3-10 Permeation Rates from Additional Test Programs Not Included in MOVES2014 Enhanced, Tier 2 (Near Zero), and Zero Evaporative Standards	
Parameter	**Value**
E0 Permeation Rate at 72 ^oF (g/hr), Enhanced Evaporative	0.0110
E0 Permeation Rate at 72 ^oF (g/hr), Tier 2/LEV II Near Zero Evaporative	0.0041
E0 Permeation Rate at 72 ^oF (g/hr), LEV II Zero Evaporative	0.0020
Increment for Ethanol-Blend Gasoline, Enhanced Evaporative	+116%
Increment for Ethanol-Blend Gasoline, Tier 2/LEV II Near Zero Evaporative	+75%
Increment for Ethanol-Blend Gasoline, LEV II Zero Evaporative	+83%

Additional observations from the permeation data analysis are summarized below.

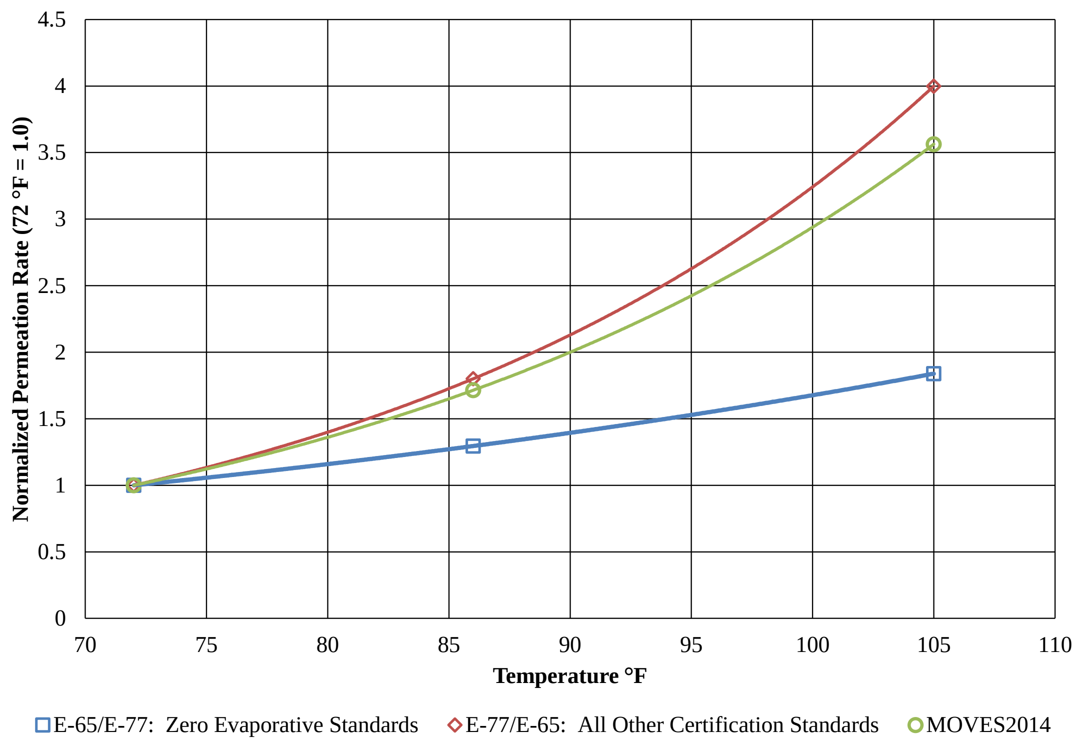
1. In the EPA multi-day study, the permeation emission rate declined with each successive day tested, showing distinctly that permeation emission rates decline for vehicles not used over multiple days. The analysis of Table 3-10 included the rate data for the first day only. There may be merit in future modeling approaches to determine separate permeation emission rates for those vehicles soaking for multiple days.

2. The permeation temperature impacts were reviewed from the combined results from E-65 and E-77. It was noted that permeation emission rates from vehicles meeting the zero evaporative standards were less sensitive to temperature variation than the rates from vehicles meeting all other certification standards; however, the sample size is small (two vehicles). The permeation-temperature curve, following the exponential format of MOVE2014, is summarized in Figure 3-2. There may be merit in future modeling approaches to determine a separate temperature adjustment for zero evaporative standards, but additional supporting test data are needed.

Tier 3 Emission Rate Review

EPA derived the Tier 3 evaporative emission rates for MOVES2014 based on the zero evaporative standards originally set as part of the California LEV II program. Generally, the derivation of Tier 3 emission rates seemed appropriate. EPA takes additional leak detection credit for the Tier 3 standards (over that which the agency estimates for the zero evaporative standard). This additional leak detection benefit is largely theoretical, but the approach is reasonable. The Tier 3 permeation rate assumption of 0.003 g/hr (E0 at 72 ^oF) is similar to that found from the analysis of vehicles meeting zero evaporative standards (0.002 g/hr, as shown in Table 3-10).

Figure 3-2
Temperature Impacts on Permeation



3.3.3 Recommendations

Three recommendations arise from the evaporative emission rate evaluation.

The first recommendation is to update the permeation rates for near zero (Tier 2) evaporative standards to reflect the significant differences between vehicles meeting these standards and those meeting enhanced evaporative standards. The contrasts with the MOVES2014 assumption that permeation rates from enhanced evaporative vehicles can be extended to Tier 2 vehicles, without modification. Sufficient data exist to improve upon this assumption and model Tier 2 vehicle permeation with distinct test data. Both the base rate and the ethanol increment are less, and the net impact would be significantly reduced permeation emissions from the current fleet commencing with the 2004 model year.

The second recommendation is to update the federal regulatory implementation schedule of evaporative standards (enhanced and Tier 2 evaporative standards) with actual sales-based estimates. Separate implementation schedules for passenger cars and light-duty trucks need to be developed because the regulatory requirements were distinct.

The third recommendation is to evaluate the potential presence of zero evaporative standard vehicles in the federal certification region. There may be vehicles certified to the California LEV II zero evaporative standard that were also certified federally (e.g., a 50-

state vehicle certified to the zero evaporative standard). An evaluation would determine the frequency of occurrence of 50-state vehicles. The analysis herein shows that permeation emissions would be less for vehicles meeting the zero-evaporative standard, but an updated evaluation would address all of the evaporative emissions processes if a significant number of 50-state vehicles were identified.

3.4 Gasoline Parameter Modeling on Exhaust

3.4.1 Overview

This element of the evaluation examined the modeling of gasoline fuel property effects on exhaust emissions in MOVES2014. New methods of modeling the effects of changes in sulfur and non-sulfur properties for late model year vehicles that had been developed in conjunction with the Tier 3 rulemaking constituted a primary model update incorporated into MOVES2014. The evaluation of this element covers both the preexisting fuel corrections (carried forward from MOVES2010) and the new fuel corrections for MOVES2014.

The evaluation examined the fuel correction regression equations, EPA resources, and independent data sources. EPA resources included the background material from the Tier 3 rulemaking,[34,35] the MOVES2010 version of the fuel corrections documentation,[36] and EPA input. The EPA provided input to verify data and methods in the absence of the MOVES2014 fuel corrections documentation, which was published in February 2016.[37]

3.4.2 Evaluation

The evaluation considered several areas, as listed and discussed below.

- Non-sulfur fuel corrections (2001 and newer model years)
- Non-sulfur fuel corrections (2000 and older model years)
- E15 modeling issues
- RVP modeling issues
- Tier 2 vehicle sulfur corrections

Non-Sulfur Fuel Corrections (2001 and Newer Model Years)

New to MOVES2014 are the 2001 and newer model year adjustments to THC, CO, NOx and PM based on regressions developed from the joint EPA/DOE/CRC E-89 EPAct Program. This program measured exhaust emissions from a matrix of 15 Tier 2 vehicles (2008 model year) and 27 test fuels.

Key achievements of these new fuel corrections are outlined below.

1. The test fleet represents late model year, Tier 2 certified vehicles.

2. The exhaust test cycle is the LA-92, which covers the full range of exhaust operating mode bins in MOVES2014.

3. Separate corrections were developed for start and running exhaust, which is highly important to inventory development as the proportion of start and running exhaust varies as a function of ambient temperature conditions.

4. The test fuel set included fuels blended with ethanol at concentrations up to 20 percent by volume or E20.

Other relevant discussion topics related to the use of these newly developed fuel corrections are summarized below.

1. The EPAct Tier 2 test vehicles were effectively new and in good operating condition, with roughly 5,000 accumulated miles on average, whereas the average on-road vehicle odometer reading is 130,000 miles.[*] So the test fleet is biased new and may not be representative of the fleet as a whole.[†]

2. Emission rates are quite low from these essentially brand-new vehicles—in particular, running exhaust emissions. Small changes in measured exhaust can result in fuel correction equations, which are calculated in relative terms, that can predict large changes in relative emissions for a small change in absolute emissions.

3. The EPAct test fuels were blended to match target values for the three distillation points of T10, T50, and T90. One reference contends that the matching procedure can yield unmatched characteristics over the remainder of the distillation curve (e.g., T60 through T80 distillation points), so the entirety of the distillation curve may not be matched. [38] Conversely, EPA contends that the EPAct fuel formulations and distillation curves fall within ranges found in market fuels that the upper half of the distillation curve successfully matched. EPA supplied full distillation curve data, and a review of these showed generally good distillation point matching in the range of T60 through T80. In the worst case, there were nominal differences in the range of T60 to T80 observed for two of the fuels used to define mid-T50 gasoline properties, but this was not indicative of gasolines overall, and it was not determined if the worst-case difference rose to the level of significance. .

4. Of the 15 test vehicles, three were FFVs and are suitably designed to operate on blends higher than E10. The remaining nine Tier 2 vehicles were not designed for operation on blends higher than E10, and this raises a question about the general

[*] The current, annual ORNL publication, *Transportation Energy Data Book,* estimates the average age of light-duty vehicles on the road in 2014 at 11.5 years; based on travel characteristics from the 2009 National Household Travel Survey, this equates to an average odometer of approximately 130,000 miles.
[†] EPA indicated that additional follow-on phases to the EPAct program will examine higher-mileage vehicles.

applicability of the EPAct predictive equations for evaluating the emissions impacts associated with the use of these fuels.*

5. The test fleet was made up of conventional FI vehicles. The characteristics of Tier 2 GDI engines, which now constitute a substantial fraction of new sales,† are sufficiently distinct that the EPAct-based estimates of fuel effects may become increasingly unrepresentative of most current, advanced-technology vehicles.

Notably, there are multiple versions of fuel corrections regressions based on the EPAct data. Both EPA and the U.S. Department of Energy (DOE) developed regression models, and within each agency's approach multiple models were developed depending on the number of significant terms included. The fuel-effect comparative analyses of this project (see Section 5) examined the ability of multiple versions of the EPAct-based models to predict the impact of the change in fuel properties from a set of independent fuel test programs. These analyses provide an indication of the accuracy of the non-sulfur fuel correction methods and the variability in estimated impact depending on the form of the predictive equation used.

Finally, additional phases of EPAct testing are on-going. One study, CRC's E-98/A-80 test program, is completed using the same 15 Tier 2 vehicles on which the MOVES non-sulfur fuel corrections are based.[74] This study is included in the fuel-effect comparative analyses of Section 5. EPA has made reference to other studies, the details of which were not provided. Including new test data into to the MOVES methods in a timely manner will be important in moving forward.

Non-Sulfur Fuel Corrections (2000 and Older Model Years)

Two separate sources provide the fuel adjustment equations used to model the exhaust emissions of pre-2001 model year gasoline vehicles in MOVES2014: the EPA Complex Model (CO version) is used for CO exhaust, and the EPA Predictive Models are used for HC and NOx exhaust. Both tools are based on test data from vehicles meeting Tier 0 exhaust standards, primarily the comprehensive testing completed by the Auto/Oil Air Quality Improvement Program. While these are comprehensive resources for modeling gasoline parameter impacts on Tier 0 vehicles, there are areas of concern, as noted below.

1. The pre-2001 model year fuel adjustment approach does not model start and running exhaust separately; the fuel adjustment approach is based on FTP composite exhaust test results.

2. The FTP-based exhaust measurements exclude the higher-power operating modes where a significant proportion of running exhaust emissions occur.

* The generally applicability of these regressions for non-FFVs will depend on whether these legacy vehicles are subsequently approved for E20 operation in the future. Currently, E15 is the maximum allowable ethanol content permitted for 2001 and newer model year light-duty gasoline vehicles.
† The EPA 2015 Fuel Economy Trends Report indicates a GDI sales fraction of 46 percent for model year 2015 (see www3.epa.gov/otaq/fetrends.htm).

3. The context for the pre-2001 model year tool development was for evaluating 1990s fuels policy. These tools are carried forward to the present in MOVES2014 and are now used to evaluate current fuel policy on the older vehicle fleet. The inventory analyses in Section 4 of this report show that the pre-2001 model year contribution to the overall exhaust inventory remains significant through 2022 (the midpoint calendar year evaluated). There are instances, sulfur content in particular, where the parameter range used to develop these tools does not match currently marketed gasolines. For example, in the EPA Predictive Models, the average sulfur specification of the underlying data record is 182 ppm, and there are multiple sulfur-interaction terms that confound the use of this tool to evaluate gasoline parameter changes in the current regulatory context at or below 30 ppm sulfur.*

E15 Modeling Issues

MOVES2014 does not restrict E15 consumption just to those vehicles approved for its use (i.e., 2001 and later model year light-duty gasoline vehicles)—rather, the model distributes E15 consumption uniformly across the entirety of the gasoline fleet. In 2022, our inventory analyses indicate that between 30 and 50 percent of ozone precursors (THC and NOx) are emitted from the gasoline fleet unapproved for E15 use (see Section 4)—i.e., pre-2001 light-duty vehicles, motorcycles, and heavy-duty gasoline vehicles. In the MOVES2014 modeling method, a significant portion of the exhaust inventory is being improperly adjusted for E15 use.

Moreover, the method by which MOVES2014 estimates E15 impacts on exhaust from pre-2001 model year vehicles is problematic. The pre-2001 model year non-sulfur fuel adjustment models (i.e., the Complex Model and the EPA Predictive Models) are allowed to extrapolate to higher ethanol blends despite the fact that no data over E10 were used in their development. This is particularly problematic when using the Predictive Model for estimating exhaust THC and NOx because both equations contain oxygen-squared terms and other multiple oxygen-interactive terms. These tools cannot be used to examine the impacts of E15 fuel use on exhaust emissions.

For additional context, it is useful to note that MOVES2014 does properly allocate E85 consumption to just those FFVs engineered for its use. The E15 modeling approach requires a similar construct in order to properly evaluate E15 use.

* It is also noted that MOVES2014 uses the Predictive Models to evaluate the change in HC and NOx exhaust only under constant sulfur conditions (sulfur corrections are handled by separate models). Because of the sulfur interaction terms in the Predictive Models, one achieves a different "fuel correction" depending on whether the "independent" sulfur correction is applied before or after the non-sulfur corrections using the Predictive Model. As such, the overall impact of combined sulfur and non-sulfur impacts depends on the order in which they are applied in MOVES2014.

RVP Modeling Issues

All three sources of non-sulfur modeling equations in MOVES2014 (i.e., the Complex Model, EPA's Predictive Models, and those based on EPAct) evaluated summer season fuel parameter variation only at the standard FTP temperature of 75°F. The maximum RVP of the underlying data used to develop each is between 10 and 10.5 psi—a suitable maximum RVP for summer season fuel modeling. Because MOVES2014 places no upper bound limit on RVP, the model extrapolates the fuel correction equations beyond these maximum RVP levels for winter season fuel modeling. A typical winter season RVP is 13 psi, but location-specific values can go as high as 15 psi.

Gasoline volatility, inherently a function of temperature, impacts gasoline exhaust emissions. When RVP is the parameter used to define volatility, the fact that RVP is a measure of gasoline volatility at constant temperature must be considered. The ability of RVP, as used by MOVES2014, to accurately model volatility impacts on exhaust depends on ambient conditions being proximate to 75 °F.[*] Therefore, the second problem with the winter season RVP modeling in MOVES2014 is the absence of RVP-temperature interaction terms that would properly estimate the amount of gasoline vapor generation in a temperature-variable scenario.

Currently, there are insufficient data to properly determine temperature-RVP interactions in winter season modeling. The most recent study of note was CRC E-74b, but the temperature range studied (from 50 to 75 °F) was not large and it found a statistically significant RVP-temperature interactive term only for exhaust CO (other pollutants evaluated were exhaust THC and NOx).[39] The impact on exhaust CO (FTP composite) from light-duty vehicles for a 9 psi to 13 psi change in RVP is shown in Table 3-11 (based on the E-74b project fuel correction regressions).

Table 3-11
Exhaust CO Impact (FTP Composite) by Certification Standard
RVP Change from 9 to 13 PSI

Temperature (° F)	Tier 1/NLEV	Tier 2
50	12%	-5%
75	54%	15%

Overall, our assessment is that the model does not have data representative of winter season modeling to accurately estimate winter season RVP impacts on exhaust.

[*] Thereby, the accuracy of the RVP modeling also comes into question for very hot conditions over 75 °F.

Tier 2 Vehicle Sulfur Corrections[*]

MOVES2014 added new capabilities for modeling sulfur content below 30 ppm for Tier 2 vehicles. The basis for the new methods was EPA's in-use sulfur test program completed to support the Tier 3 rulemaking.[34] Notable observations concerning the development of exhaust emissions adjustments for changes in gasoline sulfur through the use of these data are summarized below.

1. The approach provides an estimate of reducing sulfur below 30 ppm (to support a rulemaking limit of 10 ppm S) on exhaust emissions from Tier 2 certified vehicles.

2. The size of the in-use vehicle fleet recruited, 93 passenger cars and light trucks, is relatively large.

3. Distinct running and start exhaust impacts were determined for THC, CO, and NOx. Running exhaust impacts were significant for all three pollutants; start exhaust impacts were significant for CO only.

Outlined below are areas of potential concern with the development of the sulfur corrections.

1. With an average odometer of 30,000 miles, the test fleet is relatively new compared to an overall on-road average odometer of 130,000 miles.[†] Sulfur impacts, related to catalyst poisoning, will vary by the catalyst's in-use condition and the impacts derived from a relatively low-mileage fleet may differ from impacts from higher-mileage vehicles. It is common for sulfur studies to laboratory-age vehicle catalysts to resemble the average in-use fleet (120,000 to 150,000 miles). Testing of both "normal" and "high emitter" vehicles—completed previously for Tier 0 vehicles (representing a range of catalyst effectiveness) [37]—has not been completed on Tier 2 certified vehicles. However, EPA also cites more recent sulfur impact studies where catalyst aging/condition was not found to be a significant variable impacting the relative change in exhaust emissions.[40]

2. The largest relative impacts of sulfur changes were estimated for running exhaust. However, the FTP test cycle used in the study does not include exhaust from higher-power operating modes, where a greater proportion of running exhaust occurs. EPA has responded to comments received on the representativeness of the test cycle.[40]

3. Specific sulfur clean-out and sulfur loading procedures are integral to the test plans of sulfur studies, which are needed to determine the net effect sulfur content

[*] Sulfur corrections based on Tier 2 vehicle testing are applied to 2001 and newer model years in MOVES2014.

[†] The current, annual ORNL publication, *Transportation Energy Data Book*, estimates an average age of light-duty vehicle on the road in 2014 at 11.5 years; based on travel characteristics from the 2009 National Household Travel Survey, this equates to an average odometer of approximately 130,000 miles.

changes on vehicle exhaust. These procedures are not standardized, and their efficacy is variable and dependent upon the vehicle and catalyst hardware.[41*] In the Tier 3 rulemaking process, stakeholders raised concerns with both clean-out and loading procedures specific to the Tier 2 test program; EPA responded to those concerns.[40]

The fuel-effect comparative analyses of this project (discussed in Section 5) examined the exhaust test data from two independent studies in order to assess the MOVES2014 method for gasoline sulfur corrections applied to 2001 and later model year vehicles. These results provide a further evaluation of the reasonableness of the newly developed Tier 2 sulfur corrections of MOVES2014.

3.4.3 Recommendations

Three recommendations result from the review of gasoline parameter effects on vehicular exhaust emissions.

The first recommendation is to update the modeling method to restrict E15 use to the subset of vehicles approved for the higher ethanol blend. The recommended method would be analogous to the current method that correctly assigns E85 consumption to FFVs designed for the fuel's use. The MOVES2014 approach introduces errors in both the criteria pollutant modeling and in the assignment of speciation profiles (toxic compounds, PM speciation, and carbon bond speciation), which are also fuel formulation dependent.

The second recommendation relates to RVP impacts on exhaust emissions from gasoline vehicles under winter season conditions. Gasoline volatility, inherently a function of temperature, impacts gasoline exhaust emissions. The volatility adjustments to exhaust emissions in MOVES2014 are questionable in that they are based on data that do not cover the range of RVP and temperatures observed in the winter season. EPA should either collect and evaluate suitable data for winter season application of this exhaust emissions adjustment factor in MOVES or it should restrict the adjustment to use within the range determined by the limits of the existing available data.

The third recommendation is to update the non-sulfur fuel corrections for 2001 and newer model years to incorporate the data from the follow-up CRC E-98 project specifically, and more generally to update fuel corrections on a timely basis as new data become available. The E-98 fuel test program, relying on the 15 vehicles from the original EPAct test fleet, provides exhaust test data from additional fuels.[74] Including these in the predictive equations will improve their accuracy by incorporating more fuel parameter variation and supporting data points.

[*] Sulfur clean-out is completed by operation on aggressive driving cycles or successive wide-open throttle events to raise the catalyst temperature and purge sulfur from the catalyst. Sulfur loading has been completed using a wide variety of drive cycles and driving durations.

3.5 Fuel Formulation Data & Fuel Wizard

3.5.1 Overview

This element of the evaluation examined the default fuel inputs into MOVES2014—including the fuel formulation data, geographic fuel supply assignments, and the development of the Fuel Wizard.* This evaluation of the default fuel modeling input is important as effectively all MOVES analyses rely on the EPA-prepared, default fuel inputs; we were unable to identify any examples of local substitution of fuel modeling inputs. CRC Projects A-84 and A-88—both of which examined improving modeling MOVES inputs for the National Emission Inventory assessments—did not consider including fuel parameters in their evaluation of model input under the assumption that these are unlikely to be modified form the default values.[42,43†] As such, the accuracy of the default fuel inputs is an important evaluation element because their use by the modeling community is almost universal. This review is exclusively related to gasoline properties.

Key updates to MOVES2014 fuel inputs are noted below.

1. MOVES2014 switched from county-level fuel parameter modeling to regional fuel parameter modeling, collapsing the number of unique formulations needed to cover the entire US.

2. Under the new regional fuel modeling approach, there was a wholesale update to the fuel parameter inputs to MOVES2014.

3. EPA standardized the interrelationship between gasoline parameters in modeling RVP, ethanol content, and sulfur changes. These relationships were incorporated into the default fuel formulation data and into the Fuel Wizard tool.

It is important to understand that the fuel parameter input and supporting data used by MOVES2014 have completely changed from that used by MOVES2010. MOVES2010 was a ground-up approach using historical commercial gasoline survey data, with extrapolations assumed to cover areas for which no survey data existed. MOVES2014 uses a regional-average approach to defining fuel parameter data. For MOVES2014, conventional gasoline properties are defined by refinery gate fuel survey data with adjustments for downstream blending, and reformulated gasoline survey data have been aggregated to regional-level averages.

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* The Fuel Wizard is a new tool in MOVES2014. It facilitates the modification of gasoline parameters by automating corresponding inter-parameter relationships for conventional gasoline. For example, when modifying ethanol content, the Fuel Wizard will make changes to T50, T90, E200, and E300 properties in a manner consistent with EPA assumptions.

† This is not to say that resources for local determination of fuel parameters do not exist; the Alliance of Automobile Manufacturers publishes semiannual surveys of gasoline and diesel sold in North America resolved by city.

The evaluation covered an examination of the database fuel rate inputs, EPA resources, and independent data sources. EPA resources included the Tier 3 Regulatory Impact Analysis (where the regional fuel approach was included for the first time),[19] the FACA review material,[44] and EPA input. The EPA provided input to verify data and methods in the absence of the MOVES2014 fuel methodology documentation, which has yet to be published.

3.5.2 Evaluation

The evaluation considered several areas, as listed and discussed below.

- Regional fuel modeling
- Fuel Wizard and standardized relationships for ethanol, RVP, and sulfur
- Sensitivity cases defined from the standardized relationships
- County fuel assignments
- Fuel formulation data review
- MTBE-containing gasoline

Regional Fuel Modeling

There are 22 unique fuel regions newly defined for MOVES2014 (see Figure 3-3). Fuel regions were purportedly defined by the unique combination of (1) refinery distribution region,[*] (2) summer season RVP limit, (3) E10 waiver allowance, and (4) conventional versus reformulated gasoline. Counties are then assigned to one of the 22 regions.

In a national modeling run, under the regional fuel approach, there are approximately 40 unique gasolines defined to cover the entire US (accounting for two ethanol blend levels in each fuel region) at any point in time.[†] This is a reduction from the approximately 300 to 400 unique fuel formulations that would be used in a nationwide evaluation under the county-level fuel formulations of MOVES2010.

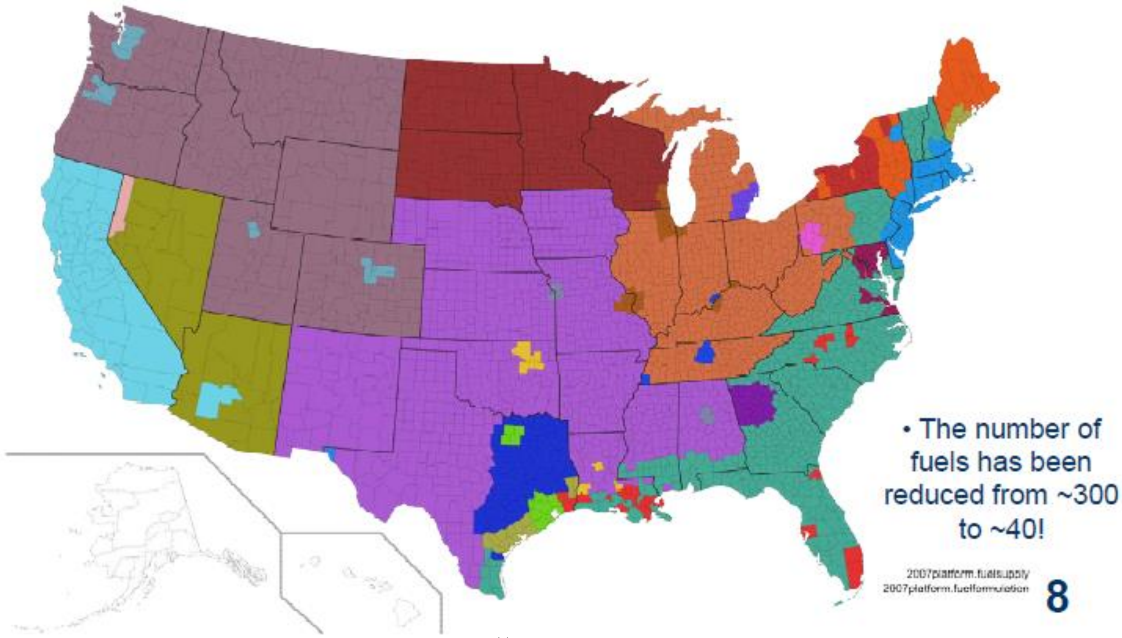
The primary gain in the new approach is the use of refinery gate data for conventional gasoline as a substantial resource of fuel formulation data that is comprehensive.[‡] One artifact of the new approach is that refinery gate data are not final commercially sold fuels as blending for ethanol and RVP occurs downstream, and adjustments to fuel parameters have to be applied to account for the blending components added to retail gasoline.

[*] A geographic region of refinery fuel distribution that is similar to (but not exactly the same as) the Petroleum Administration for Defense Districts.

[†] Depending on calendar year, the two ethanol blend levels are either E0 and E10 or E10 and E15.

[‡] The new approach loses some geographic specificity as previously completed with city-specific survey data, but it should be recognized that the spot survey data were limited in quantity, not production volume weighted, and that the coverage of the US was not complete. Additional rationale behind the switch to a regional fuel supply approach in MOVES is included in the Tier 3 rulemaking RIA (Reference 19).

Figure 3-3
EPA Map of MOVES2014 Fuel Regions



Source: U.S. Environmental Protection Agency[44]

We reviewed the adequacy of coverage of the 22 fuel regions and found that it was generally good in distinguishing most of the unique cases of PADD, summer season RVP, ethanol waiver, and reformulated gasoline requirements. The one exception identified as problematic was a single "catch-all" region (Region ID = 600000000). This one region covers all but two counties of Arizona and Nevada, and all of Alaska, Hawaii, and the U.S. territories. The areas exempt from volatility requirements (AK, HI, and territories) should be placed into a separate region from Arizona and Nevada. Moreover, Alaska and Hawaii have completely non-overlapping ASTM volatility classes, cannot be represented in the same fuel region, and should be separated from each other as well. Dealing with these issues would indicate that 24 fuel region definitions are required to properly handle the U.S. regulatory context distinctions (versus the 22 definitions assumed in MOVES2014).

We also found that the MOVES2014 regional fuel approach no longer handles the geographic phase-in area (GPA) for Tier 2 gasoline sulfur requirements applicable to Alaska, Colorado, Idaho, Montana, New Mexico, North Dakota, Utah, and Wyoming. Conversely, MOVES2010 handled this inherently. Including the GPA in MOVES2014, if desired, has to be done manually, and the modeling documentation reviewed provides no guidance on how to complete this.

We compared the default MOVES2014 fuel parameter assignments (using the regional approach) with gasoline survey data for three locations drawn from the Alliance of

Automobile Manufacturer's North American fuel surveys.* The three locations—Atlanta, Detroit, and Phoenix—are those selected for evaluation in the inventory analyses of this study (see Section 4). The results of the comparison are presented in Table 3-12 as the mean absolute difference in fuel parameter values for the three locations. Note that differences in the estimated fuel parameter values are expected in this comparison due to the inherent differences in the underlying data sources (i.e., between regional refinery gate data with final blending adjustments and city-specific spot survey data).

Table 3-12
Mean Absolute Difference between MOVES2014 Default Gasoline Parameters and Gasoline Fuel Survey Data for Three Study Locations (Atlanta, Detroit, and Phoenix)

Parameter	2011		2014	
	Winter	Summer	Winter	Summer
RVP (psi)	1.88	0.06	2.24	0.08
Sulfur (ppm)	6.17	9.73	8.58	14.73
Ethanol (%)	0.69	0.59	0.22	0.17
Aromatics (%)	2.83	2.71	3.49	1.80
Olefins (%)	0.70	4.98	1.51	3.55
Benzene (%)	0.18	0.16	0.04	0.05
E200 (%)	3.63	2.02	5.32	3.70
E300 (%)	1.67	2.34	4.15	3.25
T50 (^{o}F)	22.69	4.73	24.16	4.68
T90 (^{o}F)	18.62	11.22	20.44	7.49

There were two key results found in the comparative analysis, as outlined below.

1. Sulfur content differences were significant. It was noted in the analysis that MOVES2014 default fuel parameters for conventional gasoline consistently are the maximum average allowable (30 ppm). A significant sulfur margin (i.e., a measured sulfur content below the 30 ppm regulatory requirement) is generally observed in the fuel survey data for conventional gasolines nationally, and this margin is not accounted for in the MOVES2014 input.

* Gasoline grades from the fuel survey data were weighted 88 and 12 percent for regular and premium grades, respectively, which is the national average sales distribution based on the most recent five years of data reported by the U.S. Department of Energy's Energy Information Administration (*www.eia.gov/dnav/pet/pet_cons_refmg_d_nus_VTR_mgalpd_m.htm*).

2. The mean absolute differences between the MOVES2014 defaults and the fuel survey data also were substantial for the winter season distillation points (T50 and T90). An explanation for the differences is not apparent.

Fuel Wizard and Standardized Relationships for Ethanol, RVP and Sulfur

EPA has defined a new set of standardized gasoline parameter relationships for modeling changes in ethanol content, RVP, or sulfur in MOVES2014. The relationships, based on national refinery modeling, are factored into both the agency's preparation of default fuel formulation inputs and the development of the Fuel Wizard tool that accompanied MOVES2014.

The purposes behind these are two-fold:

- First, hard-wiring these relationships into the Fuel Wizard ensures that fuel modifications account for the interrelationship between parameters and prevents the creation of inconsistent or unrealistic fuel formulations; and

- Second, the EPA has standardized the relationship between fuels marketed within the same refinery distribution region. For example, as previously noted, two ethanol blends are generally marketed within each region at a given moment, and the difference in fuel properties for the ethanol blends is set to the uniform, standardized relationships.*

The standardized relationships for ethanol are defined for two seasons (summer and winter) and for two ethanol blend ranges (zero to 10 volume percent, and 10 percent to 15 volume percent). A single standardized relationship is defined for a change in RVP (from any initial RVP level and for any season). Three example gasoline parameter relationships are presented in Table 3-13 for a change from E0 to E10, a change from E10 to E15, and a 1.0 PSI decrease in RVP. The values reported in Table 3-13 are additive adjustments—for example, changing from E0 to E10 in the winter season changes ethanol by +10 percent, RVP by -1 PSI, aromatics by -3.65 percent, etc.

* It was not clear at the completion of this evaluation of fuel parameter data how the standardized relationships, based on national refinery modeling, interact with the downstream blending adjustments the agency makes to the refinery gate data (used to define conventional gasoline properties). The agency indicated that a separate set of blending adjustments is applied to the refinery gate data to account for downstream blending of butane (for RVP) and ethanol in determining the properties of the retail fuel. Those separate refinery adjustment values were not reviewed.

Table 3-13 Example of Standardized Gasoline Parameter Relationships from MOVES2014					
	Incremental Parameter Adjustment (Additive)				
	Ethanol (0 to 10 vol%)		Ethanol (10 to 15 vol%)		RVP (1 psi decrease)
Parameter	Winter	Summer	Winter	Summer	All Seasons
Ethanol Factor (%)	10	10	5	5	0
Sulfur Factor (ppm)	0	0	0	0	0
RVP Factor (psi)	1	1	0	0	-1
Aromatics Factor (%)	-3.65	-2.02	-2.04	-1.34	0
Olefin Factor (%)	-2.07	-0.46	-1.2	-1.18	0
Benzene Factor (%)	0	0	0	0	0
E200 Factor (%)	4.88	3.11	6.23	6.13	-1.26
E300 Factor (%)	0.54	0.39	0.47	0.52	-0.5
T50 Factor (oF)	-9.96	-6.34	-12.71	-12.52	2.57
T90 Factor (oF)	-2.45	-1.77	-2.14	-2.37	2.27

Additional tasks completed as part of this review are summarized below.

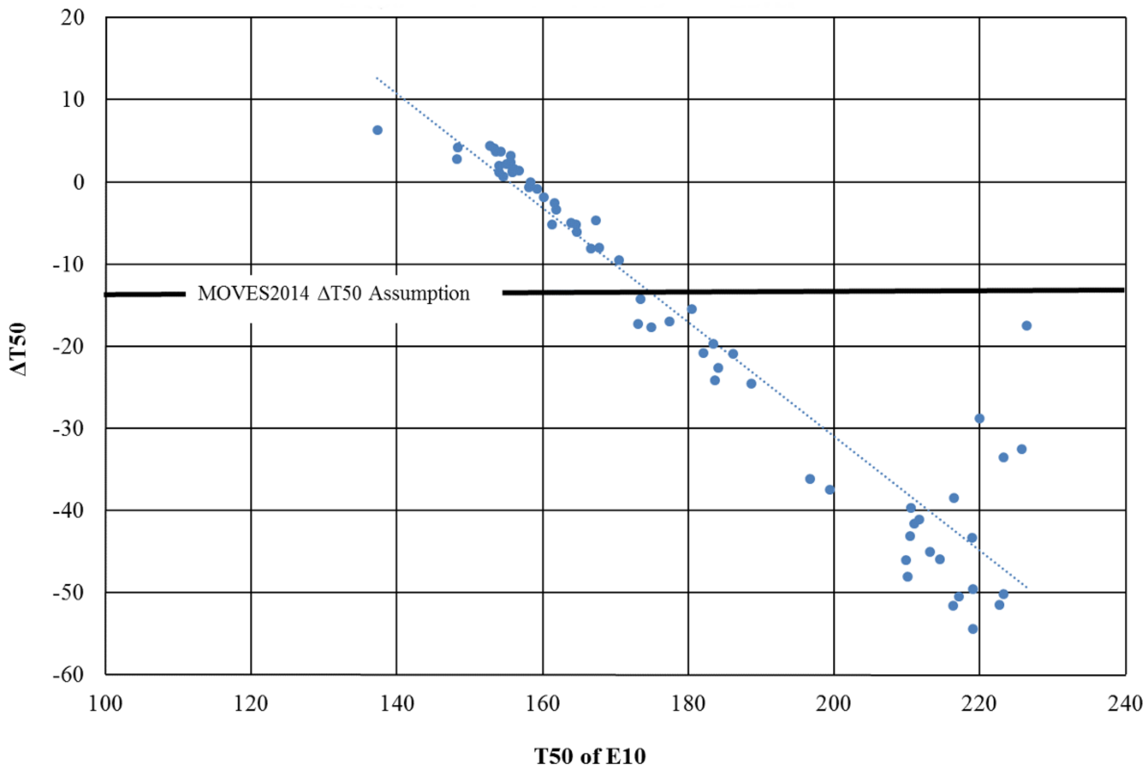
1. The Fuel Wizard tool that operates within the MOVES2014 GUI was tested and found to produce incorrect results that were off by orders of magnitude. This finding was communicated to EPA upon its discovery. Formulaic errors in the Fuel Wizard development were confirmed by EPA.*

2. The E0 to E10 standardized gasoline parameter relationships shown in Table 3-13 were reviewed. The relationships shown in Table 3-13 were found to be similar to the ethanol blending property adjustments used for certifying California fuels.[45] The T50 adjustments and the data from a recent API blending study[46] were compared showing a much broader range in the change in T50 (a 50-degree range in the change in T50 observed). Comparing MOVES2014 fuel property changes to those of California and API blending resources is notably an apples-to-oranges comparison as EPA indicates that the E0 to E10 differences of MOVES are from national refinery modeling and are not reflective of the change in properties from ethanol splash blending.

3. The standardized gasoline parameter relationships for changing from E10 to E15 were compared against the mean changes observed in the recent API blending study data[46] and found to be reasonably similar for most parameters. The case for the change in T50 is presented in Figure 3-4.

* Appendix C of this report describes review findings addressed by the MOVES2014a release, which include changes to the Fuel Wizard correcting the formulaic errors identified.

Figure 3-4
Change in T50 for E15 Blends
ΔT50 as a Function of E10 T50 Level



The range of the change in T50 is substantial. What is apparent from the T50 change (when blending E15 from E10) is that the change in T50 would be better handled as a linear function of the E10 T50 level. This comparison between the MOVES relationship between E10 and E15 and the API blending study is considered representative, because E15 is currently marketed in the U.S. through blending pumps. Blending pumps specifically add additional ethanol to the E10 blend already marketed at the retail facility.

Sensitivity Cases Defined from the Standardized Relationships

The inventory analyses completed in this project included multiple sensitivity cases (see Section 4). Two of the sensitivity cases, outlined below, were defined from the review of the standardized relationships.

1. We examined the sensitivity of the MOVES on-road inventory output to an incremental RVP increase of 1 psi both with and without use of the standardized relationships. For the case without the standardized relationships, the change in RVP was modeled only as a 1 psi increase in vapor pressure, which is how this factor has been typically modeled prior to MOVES2014. The sensitivity case was

defined to test how the standardized relationships influence the magnitude of the RVP impact on emissions.

2. The sensitivity of the on-road inventory was examined relative to a hypothetical 100% E15 implementation. The E15 modeling scenario was examined two ways: (1) by examining the EPA standardized relationship for T50 (Table 3-13); and (2) by examining a linear relationship between E10 and E15 T50 (Figure 3-4).

County Fuel Assignments

MOVES2014 assigns all counties to each of the 22 fuel regions in the *RegionCounty* data table in the default database of the model. While the data table includes a calendar year field, it was determined that the county assignments were static in that assignments did not vary by calendar year. This was unexpected as the regions define a specific regulatory context and there has been temporal variation in local fuel programs nationally. In responses to questioning on why the historical regulatory record is missing from the *RegionCounty* data table, EPA explained that a historically accurate county-region assignment would interfere with the agency's national modeling, which relies on "representative counties" in order to model the entirety of the U.S. under the constraint of a reasonable timeframe.

A review of the county assignments by fuel region in MOVES2014 indicated that these were generally good in reflecting current regulatory fuel requirements. Exceptions are noted below.

1. The assignment of reformulated gasoline areas to counties should keep the VOC Control Regions separate, as the reformulated gasoline regulation is specific to VOC Control Regions 1 and 2. There are nine counties[*] and the District of Columbia that should be reassigned to a region that is exclusively a VOC Control Region 1 area;[†] there is one county (Cecil County, MD) that should be reassigned to fuels reflecting the VOC Control Region 2.

2. There were three states (Alabama, Florida, and North Carolina) with counties with changes in summer season RVP control requirements not properly accounted for in the model defaults (in the period of 2011 to 2014).

3. Areas of Maine switched to reformulated gasoline requirements in 2015, and this was not accounted for in the model defaults.

We took the county-region assignment review one step further by evaluating the three counties used as the bases for the Inventory Analyses conducted for this project (see

[*] The counties are the nine of the St. Louis reformulated gasoline area and Cecil County, MD.
[†] This issue may have implications on the fuel formulation data for reformulated gasoline regions, as the EPA collapsed the reformulated gasoline survey data into regional averages, and those regional averages also need to keep the VOC Control Regions separate. It is not clear if the fuel formulation data were processed properly.

Section 4). Representative counties from the Atlanta, Detroit, and Phoenix metropolitan areas were modeled—Fulton, Wayne, and Maricopa Counties, respectively. Table 3-14 summarizes the local gasoline regulatory requirements governing the properties of gasoline supplied to these three counties.

<table>
<tr><th colspan="7">Table 3-14
Local Gasoline Regulatory Requirements of Three Counties</th></tr>
<tr><th rowspan="2">Calendar Year</th><th colspan="2">Fulton County (GA)</th><th colspan="2">Maricopa County (AZ)</th><th colspan="2">Wayne County (MI)</th></tr>
<tr><th>Summer</th><th>Winter</th><th>Summer</th><th>Winter</th><th>Summer</th><th>Winter</th></tr>
<tr><td>1990</td><td colspan="2">None</td><td colspan="2">None</td><td colspan="2">None</td></tr>
<tr><td>1999</td><td rowspan="4">7.0 psi RVP limit</td><td rowspan="17">None</td><td colspan="2" rowspan="17">AZ Cleaner Burning Gasoline (similar to CA CBG specifications); additional winter season RVP cap of 9 psi</td><td rowspan="8">7.8 psi RVP limit</td><td rowspan="17">None</td></tr>
<tr><td>2000</td></tr>
<tr><td>2001</td></tr>
<tr><td>2002</td></tr>
<tr><td>2003</td><td rowspan="6">7.0 psi RVP limit, accelerated implementation of sulfur limits</td></tr>
<tr><td>2004</td></tr>
<tr><td>2005</td></tr>
<tr><td>2006</td></tr>
<tr><td>2007</td><td rowspan="9">7.0 psi RVP limit</td></tr>
<tr><td>2008</td></tr>
<tr><td>2009</td><td rowspan="7">7.0 psi RVP limit (sulfur effectively superseded by federal requirements)</td></tr>
<tr><td>2010</td></tr>
<tr><td>2011</td></tr>
<tr><td>2012</td></tr>
<tr><td>2013</td></tr>
<tr><td>2014</td></tr>
<tr><td>2015</td></tr>
</table>

Instances where the default county-region assignment in MOVES2014 was inaccurate for these three counties in the 1999 to 2015 timeframe are summarized below.*

1. For Fulton County, the default fuel region assigned in MOVES2014 does not address the local sulfur requirements in effect from 2003 to 2008 (summer season). The local sulfur requirement was not one of the variables considered in the development of fuel region definitions for MOVES2014.

* We did not review the 1990 calendar year fuel formulation assumptions. Even though MOVES2014 holds the county-region assignments constant for all years including 1990, it is not clear what fuel properties are assigned in the model given that the RVP control and reformulated gasoline requirements were not in effect in 1990. Also note that MOVES2014 will not model inventories for the calendar years of 1991 to 1998, inclusive. This inventory blackout period has been in place since the first release of MOVES2010.

2. For Maricopa County, the assigned default fuel region does not correctly handle the 1999 to 2015 (winter season) period when the winter season RVP control program was in place. Winter season RVP control was not one of the variables considered in the development of the fuel region definitions for MOVES2014.

3. For Wayne County, the assigned default fuel region does not account for the 1999 to 2006 (summer season) period when the 7.8 psi regulatory cap was in effect.

It was not possible to examine the entirety of the U.S. for all possible historic changes in the fuel assignments, but the selected checks completed as part of this project indicate that the discrepancies in correctly handling local fuel regulations in total are likely quite numerous. The lack of historically accurate data regarding changes by counties to their fuel regulations is problematic with respect to state and local agencies' ability to complete air quality planning using MOVES2014. Regional modeling is inherent in air quality planning, to determine transport and to determine boundary conditions. It is advisable that the EPA take the lead in creating a version of the *RegionCounty* data table that includes the historical changes in fuel programs (as it pertains to the specificity of the new fuel regions) and to make that data table available to model users. That would at least address temporal variation in reformulated gasoline regulations, summer season RVP limits, and ethanol waivers that have occurred at numerous locations.

Fuel Formulation Data Review

The fuel formulation data of MOVES define the set of gasoline parameters for each of the fuel regions. The findings of our review of these data are outlined below.

- The Fuel Region specifically defined for Upstate New York (Region ID = 100010000) included a 1-psi summer season ethanol waiver in the fuel formulation defaults, when no such waiver is permitted.

- The Fuel Region specifically defined for California and Maricopa County (Arizona) reformulated gasoline (ID = 1570011000) incorrectly switched from 100% E10 (in 2016) to 100% E15 (in 2017). There is no regulatory mechanism for marketing E15 in California, and EPA confirmed that this single-year changeover from 100% E10 to 100% E15 was a processing error by the agency.[*]

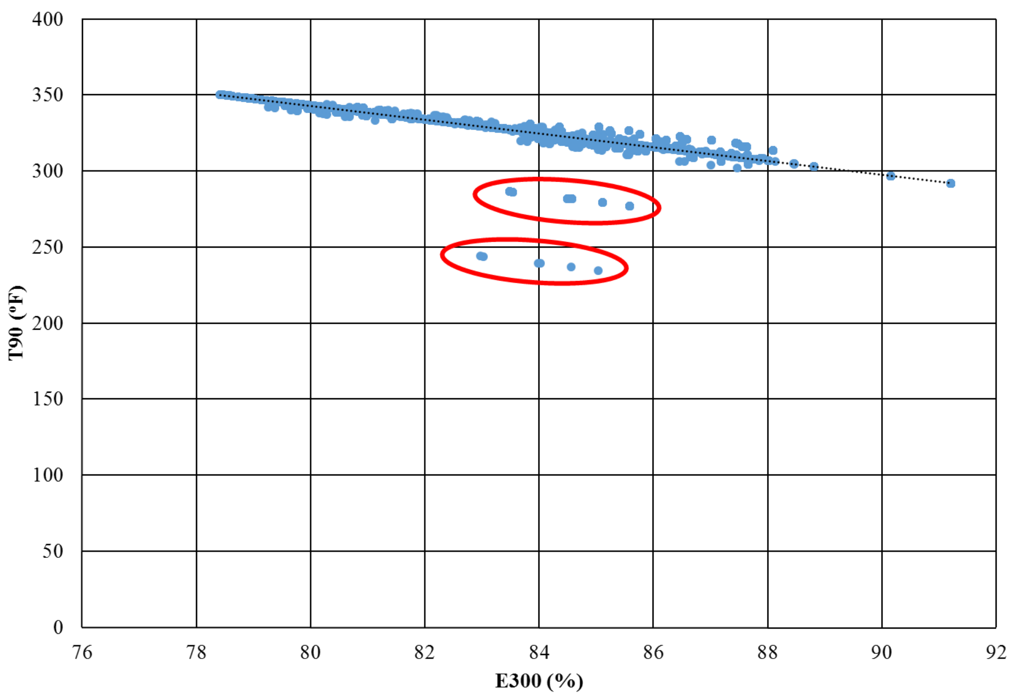
- The default E15 fuel parameters by region were defined by EPA relative to the E10 specifications in the same region following the standardized relationships shown in Table 3-13. Those differences between E15 and E10 were nationally uniform (and followed the same relationship defined for the Fuel Wizard). There were some in the default E15 parameters (relative to E10), where the E10 and E15 fuel formulation defaults did not match the difference reported in the documentation. The discrepancies were small (generally at the third significant digit) and were identified for the E15 values of T50, T90, E200, and E300.

[*] Appendix C describes review findings addressed by the MOVES2014a release, which included an update to the ethanol blend projection for the fuel region encompassing California and Maricopa County, AZ.

- EPA used the Energy Information Administration (EIA) annual publication *Annual Energy Outlook* (AEO) to develop default projections of E15 and E85 market shares—MOVES2014 relied on AEO2013. At the time of our review AEO2015 was available, and the market share data for E15 and E85 were significantly different in that later version.[*] This is not fully unexpected, as the projections of ethanol consumption required under the renewable fuel standard are highly variable and tend to change with each publication of AEO. Thereby, due to model development lead time, the ethanol blend market share data of MOVES2014 are already notably inconsistent with the most current AEO projections.[†][‡]

- There were 55 fuel formulations (out of about 6,800 total in the default database) with a questionable T90 specification. These were identified by the known linear relationship between E300 and T90, and the results identified the outliers that did not fall in line with an expected linear trend (see Figure 3-5, where the outliers are circled in red).

Figure 3-5
MOVES2014 Fuel Formulation Defaults, E300 versus T90



[*] AEO forecasts include multiple scenarios or cases. MOVES relies on the AEO2013 "Reference Case" assumptions and the comparison to AEO2015 was also completed using the Reference Case assumptions.
[†] The E15 market share of MOVES2014 was found to be considerably higher than the future-year forecast of AEO2015.
[‡] Appendix C of this report describes review findings addressed by the MOVES2014a release, which included an update to produce ethanol-blend market share projections consistent with those of AEO2015.

It was also noted that there were several errors in the data field "volToWtPercentOxy," which is the modeling variable used to convert oxygenate from a volume percent to the oxygen weight percent in the fuel. After consulting with EPA about the erroneous data, it was determined that the model no longer uses the data reported in this field (and that the values used in model calculations are hardwired within the model code). It is advisable for EPA to remove this field from the fuel formulation data table since it is no longer being used. This same suggestion also applies to the fields "CetaneIndex" and "PAHContent," which are also unused by the model.*

MTBE-Containing Gasoline

In the update to MOVES2014, EPA has removed all MTBE-containing gasolines and replaced these with ethanol blends because the latest gasoline parameter corrections based on EPAct were specific to ethanol-containing gasoline. However, this wholesale substitution of ethanol for MTBE is problematic as the RVP, evaporative permeation, and speciation impacts are significantly distinct between MTBE-and ethanol-containing gasoline. MTBE was the predominant oxygenate used between 1993 and 2003 and use of MTBE continued into 2006.†

It is our opinion that the removal of MTBE-containing fuels was not required. The EPAct fuel adjustment equations could be configured to model MTBE-containing gasoline on the basis of oxygen-content equivalency as well as a change to the "fuelSubTypeID" to ensure that ethanol-related permeation adjustments are not applied to MTBE-containing fuels. This could have been an alternate solution to substituting these fuels with an ethanol-based alternative that has significantly different emissions characteristics. Adding MTBE back into MOVES2014 would require the addition of the requisite speciation inputs as well.

3.5.3 Recommendations

Seven recommendations result from the review of the fuel formulation and fuel supply defaults to MOVES2014; there were also multiple corrections identified for this evaluation element.

The first recommendation is that EPA create a historically accurate RegionCounty data table. The problem is that the existing MOVES2014 county-to-fuel-region assignment is static (identical for all calendar years). The data table is already configured to allow for calendar year assignment to fuel regions and this functionality should be utilized to ensure that the fuel region definitions actually match the historical regulatory record, as best as possible given the limitations of the fuel region definitions themselves. This table can be created and distributed to MOVES users and does not need to wait for an official model release.

* In the default database, the fields for "CetaneIndex" and "PAHContent" are consistently blank.
† Source EIA's *Annual Energy Reviews* as summarized at *www.afdc.energy.gov/data/10322*.

The second recommendation is to increase the number of fuel regions from 22 to 24in order to properly distinguish all possible combinations of underlying regulatory context. Currently there is a single region that encompasses all but two counties of Arizona and Nevada along with Alaska, Hawaii, and the U.S. territories. The areas exempt from volatility requirements (AK, HI, and territories) should be placed into a separate region from AZ and NV. Moreover, AK and HI have completely non-overlapping ASTM volatility classes, cannot be represented in the same fuel region, and should be separated from each other as well. This would raise the number of unique fuel regions to 24.

The third recommendation is to return MTBE-containing gasoline to the historical data record. MOVES2010 could handle MTBE as an oxygenate; MOVES2014 cannot. MTBE was an important fuel additive for several years. MOVES2014 should retain its ability to model historical fuels as well as forecast forward. The current MOVES2014 solution of using an ethanol blend in place of the MTBE blend misrepresents historical fact.

The fourth recommendation is that EPA should develop explicit guidance or a modeling tool to assist state and local agencies to regularly incorporate EIA's *Annual Energy Outlook* into market share forecasts of the various ethanol blends. This would transfer the responsibility of keeping ethanol market share assumptions current to the MOVES users. The E15 market share assumed in MOVES2014 is not current with the latest AEO publication simply due to the lead time needed for model development. The MOVES2014 forecast for E15 usage is considerably higher than that currently forecast by the EIA.[*]

The fifth recommendation is to incorporate data-derived sulfur content of conventional gasoline for the period from 2011 through 2016. For these years, the fuel input data of MOVES2014 assumes the sulfur content of conventional gasoline equal the maximum allowable average of 30 ppm sulfur. The data reviewed for this project suggest that the actual sulfur content was below 30 ppm.

The sixth recommendation is to remove the unused fields of "volToWtPercentOxy," "CetaneIndex," and "PAHContent" from the fuel formulation data table as their presence is misleading. At a minimum, the incorrect values of "volToWtPercentOxy" need to be removed, and—given that the field is not used by the model—it would be preferable if every entry for this field were blank in the default database.

The seventh recommendation is to modify the standardized relationships between E10 and E15 to include a linear change in T50, based on the T50 of the E10 gasoline to which the additional ethanol is added.

Listed below are multiple corrections identified as part of the evaluation of the fuel formulation and fuel supply defaults.

[*] As described in Appendix C, the MOVES2014a release included an update to make ethanol-blend market share assumptions consistent with AEO2015.

1. The default fuel formulation data for the fuel region specifically defined for Upstate New York (Region ID = 100010000) needs to remove the 1-PSI summer season ethanol waiver as no such waiver is permitted.

2. There are 55 fuel formulations identified with a questionable T90 specification. These were identified by the known linear relationship between E300 and T90, and the outliers need to be reviewed and corrected.

3. The Fuel Region specifically defined for California and Maricopa County reformulated gasoline (ID = 1570011000) needs to be corrected for E15 market share from 2017 onward. Given that there is no regulatory mechanism for marketing E15 in California, the market share should be set to 100 percent E10.[*]

4. Our review of federal reformulation gasoline assignments recommends corrections to the county-region assignments for three locations (St. Louis, Missouri/Illinois; the District of Columbia; and Cecil County, Maryland) so that the results are consistent with the VOC Control Region applicable to each location.

3.6 Activity Data

3.6.1 Overview

We examined EPA's estimates of activity data inputs for MOVES2014. The key updates undertaken by the agency are outlined below

1. Updated fleet and activity data were developed and incorporated to create a new calendar year 2011 baseline (i.e., the latest year based on historical data).[†] The data used for post-2011 fleet and activity projections were updated to support model evaluations through to 2050.

2. The model includes new flexibility for the option to input vehicle trip activity data.[‡]

3. New speed distribution data were developed for the model. Additional heavy-duty driving cycles were developed to expand the distribution of speeds modeled.

4. Activity data were incorporated into the model to support multiple-day cold soaks —also known as multi-day diurnals—which are a new evaporative emissions source for MOVES2014.

[*] As described in Appendix C, the MOVES2014a release included an update to eliminate the E15 changeover in the fuel region for California and Maricopa County, AZ.
[†] In MOVES2010, the model included historical data through calendar year 2007.
[‡] Please note the equivalency of the terms "trips" and "starts" in this discussion of activity data for MOVES2014. In many instances, the EPA resources refer to "starts" activity; this document gives preference to the historically more common term "trips." But the two terms as used herein in this discussion of vehicle activity are equivalent.

The evaluation examined the database inputs, EPA resources, and independent data sources. EPA resources included the MOVES2014 methodology document for activity data,[47] the FACA review background material,[48] and EPA input.

3.6.2 Evaluation

The evaluation considered several areas, as listed and discussed below.

- New trip activity inputs
- Relative mileage accumulation rates and VMT distribution
- EPA age distribution tool
- Use of VIUS data

New Trip Activity Inputs

MOVES2010 contained two bases for activity input—VMT and vehicle population. In MOVES2010, vehicle trips were estimated as a function of vehicle population, accounting for age and vehicle class difference through the data contained in the *sampleVehicleTrip* data table. The proper estimation of trip activity is important for the emission inventory assessment. For example, start exhaust is increasingly a larger share of the total exhaust emissions, and start exhaust (as estimated by MOVES2010) relied on vehicle population as the activity basis.

MOVES2014 provides the option to decouple the link between trips and vehicle population, such that the user can independently specify all three activity bases of VMT, population, and trips. The model default case continues to rely on the population-trip relationship through the *sampleVehicleTrip* data table; however, MOVES2014 allows for the option of user-supplied trip data.

It is important to note that the new input functionality for the direct input of trip data also includes the option for supplying data for the soak distribution (i.e., the distribution of time parked between trips). It is important that any new trip data are properly coupled with updated soak distribution data.

Historically, there are three means for estimating vehicle trip data: (1) instrumented vehicles, (2) travel demand models, and (3) driver surveys. There is a profound difference in the number of trips estimated by each source. Technically, a trip is the time elapsed between any ignition key-on and ignition key-off event, and only instrumented vehicles capture the full scope of vehicle trips. If a MOVES modeler is allowed to input trips based on travel demand modeling, then the soak distributions require updating for consistency.[*] This issue is important enough that the EPA should issue guidance on how to develop trip and soak input data for use in MOVES.

[*] Travel demand modeling represents a simplified approach to trip generation based on trip purpose. It can undercount trips in succession—the frequent trips completed in a series of short soak duration—when compared to instrumented vehicle data, which by definition capture all key-on and key-off events. If a user

Overall, the approach taken by the EPA is sound because it allows for both trips and soak distribution data to be specified by the user, and it is important for inventory accuracy that these inputs be defined consistently.

Relative Mileage Accumulation Rates and VMT Distribution

Both MOVES2010 and MOVES2014 rely on the parameter “relative mileage accumulation rate” (also referred to as “relative MAR” or “RMAR” in the documentation) as an integral component of the activity method as it relates to the model’s internal calculations for VMT distributions by age and by source type.[*]

The relative MAR is specifically defined as the annual mileage accumulation rate by source type and by age normalized such that highest value observed within the HPMS vehicle type is assigned to unity.[†] This definition may not be obvious to all—the renormalization of those source types that fall within a single HPMS type requires an understanding of the overlapping vehicle class schemes used to defined the activity data input. The vehicle types that make up the two schemes of source type and HPMS type are shown in Table 3-15.

The MOVES documentation could improve the discussion of the role of the relative MAR in the activity data calculations. It performs two distinct levels of VMT redistribution: (1) from HPMS type to source type, and (2) from fleet average to individual vehicle ages (up to age 30, the oldest tracked by the model).[47] This role has become even more important with MOVES2014 as all four-wheel, two-axle vehicles are now covered by a single HPMS vehicle type (i.e., “light-duty vehicles” shown in Table 3-15).[‡] Light-duty vehicle VMT constitutes more than 70 percent of the total on-road VMT nationally. The relative MAR is the variable that defines how this VMT gets distributed by source type and by age.

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is allowed to alter the number of trips based on travel demand modeling, but leaves the default soak distribution intact (which is based on instrumented vehicles in MOVES2014), the result would be an inconsistent matching of emissions associated with trip starts and trip ends (i.e., soak distributions).

[*] The “source type” is the primary vehicle classification by which inventories are processed.

[†] This definition has to be deduced from the information presented in a 2009 draft version of the Software Design and Reference Manual (SDRM) and from a trial-and-error process of working with the activity inputs of the model. The SDRM for MOVES2010 was never released (a version from Draft MOVES2009 was published). The SDRM for MOVES2014 makes no mention of the parameter.

[‡] In MOVES2010, separate HPMS types were defined for passenger cars and light-duty trucks.

Table 3-15
"Source Type" and "HPMS Type" Vehicle Classification Schemes

Source Type	HPMS Type
Motorcycles	Motorcycles
Passenger Cars	Light-Duty Vehicles
Passenger Trucks	
Light Commercial Trucks	
Intercity Buses	Buses
Transit Buses	
School Buses	
Refuse Trucks	Single Unit Trucks
Single Unit Short-Haul Trucks	
Single Unit Long-Haul Trucks	
Motor Homes	
Combination Short-Haul Trucks	Combination Trucks
Combination Long-Haul Trucks	

Importantly, the normalized definition of the mileage accumulation rate is not necessary and upon normalization the significance of the data is made more difficult to interpret and use. The model should be directly set up to allow the input of annual mileage accumulation rate data (in miles per year) resolved by source type and by age in place of the relative MAR. The model code would then perform any required normalization calculations between the two vehicle classification schemes that this parameter interacts with internally.

In conversations with stakeholders about this topic, it was noted that how VMT is distributed internally by the model has confounded the modeling community. It was also noted that the EPA is considering additional user input options for directly entering VMT by source type that circumvents a portion of the VMT distribution calculations. There have been requests for the option to directly input VMT apportioned for passenger cars and passenger trucks separately, and metropolitan planning organizations (MPOs) have reported difficulty replicating their VMT by source type within their MOVES2014 evaluations.[*] At the crux of this issue is the VMT distribution functions performed by the relative MAR.[†]

As such, it would be an improvement if the relative MAR definition were converted to an annual mileage accumulation rate expressed in absolute miles per year. It would also be beneficial if VMT could be entered for vehicle classifications other than the HPMS vehicle type, thus circumventing some of the redistribution calculations of the model; this

[*] Based on conference calls completed with the FHWA and representative MPOs in the course of this work.
[†] The VMT distribution calculations completed by the model using the relative MAR were validated as part of this review, and it was determined the VMT calculations are being completed as designed.

is a change that the agency is already considering.* Either of these changes would facilitate the incorporation of locally derived mileage accumulation rates where available[49] or locally estimated VMT by source type. Previous Emission Inventory Improvement Program (EIIP) guidance outlined procedures for estimating location-specific mileage accumulation rate data for inclusion in the application of the MOBILE model.[50]

EPA Age Distribution Tool

EPA has released an age distribution tool to accompany MOVES2014. This tool takes a base-year age distribution of vehicle population (i.e., the latest historic year available) and forecasts it forward in time to create an estimated future-year age distribution. This tool was reviewed as part of the examination of the activity modeling capabilities of MOVES2014. The underlying parameters supporting the tool are national-average vehicle survival rates and sales projections. Age distribution input to MOVES2014 is resolved by source type (see Table 3-15), and the tool supports calculations by vehicle source type.

EPA inventory guidance allows stakeholders to apply the age distribution tool or to simply hold age distributions constant (at the most recent historic year available).[51] The advantages of the tool are the ability to forecast forward a variable-aged fleet impacted by the cyclical nature of the economy—and its impact on new vehicle sales—given that historical perturbations in populations will continue to exist until the fleet retires. However, the tool is not without certain uncertainties, as noted below.

1. Survival rates, the rate at which a vehicle of vintage X survives to the subsequent year, defined at the national level may not match local conditions. There is a substantial impact of winter road treatment (i.e., salt applications) on vehicle survival rates in colder regions.

2. Survival rates defined within a given source type do not differ between gasoline and diesel engine applications, which can have significantly different survival rates.[52]

3. The age distribution tool relies on an approximate value of a 30 percent survival rate for the final model year tracked by MOVES (age = 30).† This survival rate at 30 years old is applied to all vehicle classes from motorcycles to combination trucks and is not data derived.‡ Survival rates do not drop off to this level at this age and the 30 percent value is substantially low.[8,52] Implications are significant for projecting heavy-duty vehicle populations currently estimated to have a median lifetime of 28 years.[53]

* As described in Appendix C, the MOVES2014a release included an update to allow users to input VMT by source type.

† The survival rate, as noted at (1), is the year-over-year survival rate. In this assumption, 30% of 30-year-old vehicles survive to the next year and 70% are scrapped.

‡ This value serves to truncate the oldest vehicles that the model simply does not track.

4. The tool does not address vehicle migration, which can be locally important; significant numbers of vehicles entering or leaving a region is not accounted for by the use of survival rates to project the age distribution. Moreover, for short-haul and long-haul combination trucks, migration is inherent in the definition of these two source types. The tool performance has difficulty even at the national scale for these two heavy-duty vehicles due to the inability to address migration.*

It is our recommendation that the age distribution tool be applied cautiously. It has key advantages for short-term projections where uncertainty in the underlying data is relatively less; for long-term forecasts, however, the increased uncertainty (for the reasons stated above) may outweigh the utility of the tool. The end result of the age distribution tool forecast should always be reviewed for reasonableness against the original base-year distribution. And the option exists to use the tool for certain source types (e.g., light-duty vehicles) while holding the age distribution of other source types constant (e.g., short- and long-haul combination trucks).

Use of VIUS Data

The U.S. Census Bureau produced the Vehicle Inventory and Use Survey (VIUS) every five years before discontinuing it after 2002. This resource is fundamental to the proportional distribution of truck populations and VMT into the source types of passenger trucks; light commercial trucks; single-unit, short-haul trucks; single-unit long-haul trucks; combination short-haul trucks; and combination long-haul trucks (see Table 3-15).

MOVES2014 continues to rely on the two most recent versions of VIUS (1997 and 2002). These resources are out of date. The EPA should either consider the effort to reproduce these data on its own in the absence of an effort by the U.S. Census Bureau, or alternatively, the fundamental truck source types of MOVES should be changed to a scheme that is supported by regularly collected data.

3.6.3 Recommendations

There are two recommendations resulting from the review of the activity data inputs.

The first recommendation is that a future update to MOVES include the mileage accumulation rates input into the model defined in absolute terms, i.e., reported in miles per year. This would replace the current modeling input known as the relative MAR.

The second recommendation is that EPA provide additional guidance on recommendations and suggestions for preparing vehicle trip activity inputs in combination with vehicle soak distributions. This would provide further context on how these two inputs are inherently related, and it is important for inventory accuracy that these be defined in a consistent manner.

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* Combination trucks tend to be in “long-haul” vocations when newer and in “short-haul” vocations when older. The age distribution of the two source types is modeled separately by the tool as if these are mutually exclusive vehicle types when indeed migration between the two is common.

3.7 Temperature Corrections

3.7.1 Overview

This element of the evaluation examined the temperature corrections to MOVES2014. The key updates were to evaluate and incorporate new temperature corrections based on testing completed for the mobile source air toxics (MSAT) rulemaking.

The evaluation covered an examination of the database inputs, EPA resources, and independent data sources. EPA resources included the MOVES2014 methodology document for temperature corrections [54] and the FACA review background material.[55]

3.7.2 Evaluation

This evaluation element covered the temperature corrections to exhaust emissions in MOVES2014. Overall, the EPA incorporated newer data based on the testing used to support the MSAT rulemaking. Those updates, which were used to update temperature corrections for Tier 2 vehicles, categorically improved the model's prediction of temperature impacts on exhaust. Two noteworthy additional topics related to this review are discussed below.

Temperature Corrections for PM Running Exhaust

MOVES2010 included a temperature-exhaust impact for PM running exhaust from gasoline vehicles based on the 2005 Kansas City test program. This inventory impact—that PM running exhaust is impacted by ambient temperature—is contrary to engineering expectation that a fully warmed-up engine and emission control system would not exhibit variation in running exhaust emissions as a function of ambient temperature, for criteria pollutants generally or PM specifically.[*] The MOVES2014 technical support document covering temperature corrections includes the following statement related to the PM results from the Kansas City test program.[54]

> *The re-analysis of Kansas City study suggested that, as suspected, much of the running temperature effect apparent in bag 2 is due to the short warm-up in bag 1 of the LA-92.*[†]

The MOVES2010 result, based on the Kansas City data, may be the artifact of a portion of start exhaust PM carrying over into the PM running exhaust data. That result is not an error; it comes from the testing protocol. A key consideration for future research is that the LA-92 may not represent sufficient warm-up time for cold-temperature test programs when assessing separate impacts for start and running exhaust.

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[*] For MOVES2010, particulate matter was the only criteria pollutant in gasoline vehicle running exhaust found to have a temperature dependence.

[†] Bag 2 is the running exhaust portion of the LA-92 test cycle; Bag 1 is the cold start exhaust portion of the test cycle.

The new Tier 2 temperature corrections developed for MOVES2014 did not yield any temperature dependence for PM running exhaust, using the FTP test cycle as the exhaust measurement basis. This is more in line with engineering expectation. Note that the MOVES2010 method for examining temperature impacts on PM running exhaust from pre-Tier 2 vehicles is still retained in MOVES2014.

Temperature Corrections for Heavy-Duty Diesel THC Exhaust

There were unexpected issues identified in the evaluation of heavy-duty emission rates related to THC start exhaust emissions. Although the technical support document for heavy-duty emission rates stated that for most diesel vehicle classes there are no THC start exhaust emissions,[6] MOVES2014 output reports THC start exhaust emissions for these vehicle classes. This was initially believed to be an error in the modeling method.

Ultimately, the unexpected start exhaust results turned out to be an artifact of the model's methodology for temperature adjustments to THC running exhaust for the vehicle classes in question. The temperature correction method for the diesel vehicle classes is an additive exhaust increase, as is discussed in the respective documentation on temperature corrections.[54] It is expected that the modeling method to allocate an additive increase in exhaust as "start exhaust" rather than add these emissions to the running exhaust was preferable at some level. Therefore, the MOVES2014 method for the temperature adjustments inadvertently creates and reports "startup exhaust" in the output, when the emission rate background documentation states that no startup exhaust exists for these vehicle classes.[6] While a bit confusing, the total exhaust results produced are correct; it is merely how the exhaust emissions are classified in the model output that was unexpected.

3.7.3 Recommendations

There were no issues of significance identified for the evaluation topic, and there are no recommendations or corrections that resulted from the temperature correction method review.

3.8 Chemical Speciation

3.8.1 Overview

This element of the evaluation examined the toxic compound speciation, PM speciation, and TOG speciation features of MOVES2014. The key updates are listed below.

1. New functions to speciate emissions of PM and TOG, to support photochemical air quality model evaluations (e.g., the Community Multi-scale Air Quality [CMAQ] model), were added to MOVES2014.

2. New speciation profiles for Tier 2 gasoline vehicles were developed, including data specific by ethanol blend level up to 15 percent by volume. These were developed from the results of the EPAct test program (EPAct was also the data source for fuel adjustment methods for criteria pollutants, as discussed in Section 3.4).

The evaluation covered an examination of the database inputs, EPA resources, and independent data sources. EPA resources included the MOVES2014 methodology documents for speciation,[56] [57] the FACA review background material,[58] [59] [60]and EPA input.

3.8.2 Evaluation

The evaluation considered several areas, as listed and discussed below.

- SMOKE versus MOVES application of air quality model speciation
- Diesel crankcase speciation
- E85 speciation

SMOKE Versus MOVES Application of Air Quality Model Speciation

Air quality model photochemical mechanisms (e.g., carbon bond 6 or CB6) contain a simplified set of equations that use representative "model species" to represent atmospheric chemistry. The newly developed TOG and PM emission inventory speciation functions of MOVES2014 develop the on-road inventory input by the requisite model species. Prior to MOVES2014, this functionality would typically be completed by the inventory processing software known as SMOKE.[*]

Historically, both the MOVES2010 and SMOKE models independently performed various speciation calculations and the results were not always consistent. For example, MOVES2010 included the capability to model both PM and speciated PM components, and the SMOKE model would apply speciation profiles to convert PM inventory results into speciated PM components. It was possible to obtain differing proportions of PM as organic carbon and elemental carbon depending on whether MOVES or SMOKE was used to perform the calculations. The new MOVES2014 approach, at the basic level, largely incorporates the TOG and PM speciation functions of SMOKE.

Completing air quality model speciation functions within MOVES2014 (as opposed to using SMOKE) has key advantages. Speciation profiles can vary by vehicle class, fuel type (e.g., ethanol blend level), model year, and emissions process. In order to apply unique speciation profiles in SMOKE, the emission inventory would have to be separated into each source associated with a unique profile (i.e., a high-level of disaggregation). Allowing MOVES to apply speciation profiles internally allows for a detailed level of

[*] Sparse Matrix Operator Kernel Emissions (SMOKE) is a computer program used to provide photochemical model-ready inputs into CMAQ. SMOKE produces gridded, speciated, and hourly emissions input for use in CMAQ and other air-quality models.

speciation profile assignment without having to unnecessarily fragment the on-road emissions inventory.

Completing TOG and PM speciation within MOVES2014 also offers potential for future improvements. New speciation profiles can be developed for new cases and incorporated into MOVES more readily than would be otherwise possible had speciation continued to occur outside the model. One key improvement would be to develop separate speciation profiles for start and running exhaust from gasoline vehicles. Current MOVES2014 profiles are a FTP-weighted average of start and running exhaust, and these proportions vary considerably based on modeling scenario conditions. The speciation characteristics of start exhaust, occurring before the catalyst and control system are fully warmed up, are significantly different from the running exhaust speciation characteristics.[61] It would be a significant improvement to have separate speciation profiles for start and running exhaust, and to allow the model to combine the exhaust components in proportion to those estimated under the modeling scenario conditions.

Diesel Crankcase Emissions Speciation

The method by which MOVES2014 speciates diesel exhaust and crankcase PM emissions was reviewed in greater detail. These PM emissions were of interest because the review of heavy-duty diesel emission rates (described in Section 3.1 of this report) indicated that the characteristics of these two PM sources were significantly distinct. Diesel exhaust PM is primarily the result of unburnt fuel; diesel crankcase PM is primarily the result of vaporized engine oil. The two have demonstratively different chemical components. [62]

Overall, the MOVES2014 approach handles the speciation distinctions between these two emissions sources adequately. For example, crankcase PM has a much greater proportion of organic carbon (OC) than exhaust PM, and this is correctly handled in the model's method. This is another validation that having MOVES2014 perform speciation calculations is a superior approach, as this allows for the distinct handling of diesel crankcase and exhaust PM emissions.

E85 Speciation

The method by which MOVES2014 speciates exhaust and evaporative emissions from FFVs was examined in greater detail to ensure that this light-duty vehicle subset was properly handled, given that it is distinctly unique. Of interest was the difference in speciation between E85 and gasoline, as these vehicles can operate on either fuel.

We found, unexpectedly, that MOVES2014 does not properly speciate FFV exhaust, due to either a programming or a database error. Based on the review completed, it was determined that FFVs operating on gasoline were processed correctly by MOVES2014; the processing of FFVs operating on E85 resulted in errors, however, with the model predicting zero emissions where emissions were expected. There were approximately 100 pollutant-process combinations that failed to produce emissions, which appears to be a modeling error. This is apparently a speciation issue as it relates only to speciated compounds and not to the direct reporting of criteria pollutants (i.e., THC, CO, NOx, and PM). A subset of the cases of missing emissions is reported in Table 3-16.[*†]

Table 3-16
A Subset of Instances Where MOVES2014 Reports Zero Emissions for FFVs Operating on E85

Pollutant	Emission Process
Volatile Organic Compounds	Refueling Spillage Loss
Volatile Organic Compounds	Refueling Displacement Vapor Loss
Volatile Organic Compounds	Evaporative Fuel Leaks
Volatile Organic Compounds	Evaporative Fuel Vapor Venting
Volatile Organic Compounds	Evaporative Permeation
Benzene	Evaporative Permeation
Benzene	Evaporative Fuel Vapor Venting
Benzene	Evaporative Fuel Leaks
Benzene	Refueling Displacement Vapor Loss
Benzene	Refueling Spillage Loss
Ethanol	Evaporative Permeation
Ethanol	Evaporative Fuel Vapor Venting
Ethanol	Evaporative Fuel Leaks
Ethanol	Refueling Displacement Vapor Loss
Ethanol	Refueling Spillage Loss
2,2,4-Trimethylpentane	Evaporative Permeation
2,2,4-Trimethylpentane	Evaporative Fuel Vapor Venting
2,2,4-Trimethylpentane	Evaporative Fuel Leaks
2,2,4-Trimethylpentane	Refueling Displacement Vapor Loss
2,2,4-Trimethylpentane	Refueling Spillage Loss

3.8.3 Recommendations

One recommendation results from the review of the speciation methods, and there is one correction identified for this evaluation element.

It is recommended that EPA consider incorporating separate profiles of speciated VOC start-up and running exhaust emissions from gasoline vehicles into future versions of the MOVES model. This would build from the CRC A-84 project, which worked with speciation data from Tier 2 vehicles.[61] Ideally, data covering the entirety of the on-road

[*] EPA was notified of these findings upon discovery.
[†] As described in Appendix C, the MOVES2014a release included an update that corrected the E85 speciation issues identified.

fleet, as possible, would be evaluated and the distinction of exhaust into startup and running components would be defined consistently with the MOVES method.

The correction relates to the speciation of FFV evaporative emissions while operating on E85 fuel. There were a number of instances where the model produced zero emissions from FFVs, when emissions were expected. Conversely, the model properly produces emissions from FFVs while operating on conventional gasoline. The instances with zero emissions always involved when HC was reported as VOC and included individual pollutants that were speciated from VOC emissions. Thereby, the expectation is that this is an error involving the speciation methods of MOVES2014.*

3.9 Vehicle I/M Programs

3.9.1 Overview

An examination of vehicle I/M programs was not originally proposed as an evaluation element for this project because the I/M modeling method and supporting data had not changed from that developed for MOVES2010. In the course of completing this project, however, we realized that certain elements of the I/M program methods in MOVES2014 warranted further review. Those items are described below.

This review focused on outputs from MOVES2014 I/M modeling runs, which we then tried to reconcile with the information reported in the EPA documentation.[17,54] Key results of this review were also provided to the EPA for comment and consideration.

3.9.2 Evaluation

The evaluation examined (1) the fundamental I/M approach and (2) I/M impacts on start exhaust for 1981 and newer model year light-duty vehicles; the underlying assumptions for 1980 and older vehicles were not examined.

Fundamental I/M Approach

In the course of the review of the light-duty gasoline emission rate documentation,[16,17] it was observed that the reporting of non-I/M ratios (i.e., ratios of emissions for vehicles not in an I/M area to vehicles in I/M areas) for running exhaust emissions of CO, HC, and NOx by age groups was unexpectedly simplistic. Absent were the expected variation in non-I/M ratios by vehicle class (e.g., passenger cars vs. light-duty trucks) and the expected variation in non-I/M ratios by test type (e.g., IM240 vs. OBD MIL). A more detailed examination of the model benefits assigned to running exhaust by test type, vehicle class, age, and pollutant was completed to validate the documented method. The analysis was completed for the Reference I/M case, which is the Phoenix I/M program on which the

* As described in Appendix C, the MOVES2014a release included an update that corrected the E85 speciation issues identified.

light-duty gasoline exhaust base rates are based. To simplify the analysis, the I/M compliance rate was set to 100 percent.

It was determined that there is a subset of cases where the model was applying additional I/M benefits beyond those assigned to the Reference I/M case, as suggested by the non-I/M ratios reported in the documentation:

1. Passenger cars, model years 1981-1995, ages 10+ only; and
2. Light-duty trucks, model years 1981-1995, all ages.

The additional I/M benefits are created by I/M adjustment factors that are not unity for the Reference I/M case; the I/M adjustment factors in question are greater than unity. This situation is inconsistent with the underlying model method, as the I/M emission rates are inherently representative of the Reference I/M case, and the model method is applying additional I/M benefits through the I/M factors to the I/M emission rates developed from the Arizona I/M program.

The correction to this problem involves the steps outlined below.

1. The "no-I/M case" of the default emission rates inputs into MOVES2014 needs to be corrected for model years 1981 through 1995 for the vehicle classes and ages reported above. The non-I/M ratios need to be redefined to include the full difference in emission rates between no-I/M and with-I/M such that the model's I/M adjustment factors for the Reference I/M case are, by definition, always unity. This means that the non-I/M ratios will exhibit more differences by vehicle class and by model year than currently exhibited in the default emission rates.

2. The I/M adjustment factors for the Reference I/M case, by definition, will be unity for consistency with how the no-I/M and with-I/M emission rates are prepared. Having I/M adjustment factors of unity is the only means by which the I/M base rates going into the model will be the same as the I/M rates output by the model.

3. The I/M adjustment factor data for I/M programs other than the Reference I/M case need to be renormalized for consistency with (1) and (2) above.

This correction will result in higher no-I/M emission rates (for the vehicle class, model year, and age combinations noted above) and will also result in higher I/M emission rates coming out of the model for Reference I/M (and for all other I/M programs that are scaled from the Reference I/M program). We examined a corrected analysis for Phoenix (2011, July weekday) and found increases in the total on-road exhaust inventory, for all vehicle classes and fuel types, as listed below.

- Exhaust THC = +7.1%
- Exhaust CO = +2.5%
- Exhaust NOx = +1.4%

Our understanding is that all inventories (both with-I/M and no-I/M) are impacted by this modeling issue. The size of the inventory impact will increase moving backward in time from 2011. The expectation is that running exhaust emission rates are nominally higher for both I/M and no-I/M cases than is currently assessed by MOVES2014.

I/M Impacts on Start Exhaust

The gasoline vehicle emission rate support documentation does not fully address the topic of I/M benefits for start exhaust—it explicitly discusses only how running exhaust is impacted by I/M.[17] Notably, though, both running and start exhaust have I/M impacts in MOVES2014.

As described in the light-duty gasoline exhaust review (see Section 3.2) start exhaust deterioration was not directly ascertained within the development of emission rate inputs for MOVES2104. Start exhaust deterioration is modeled by an adjustment ratio approach that scales start exhaust deterioration from that observed for running exhaust. The same adjustment ratio is applied in the development of MOVES2014 emission rate inputs for both the I/M and no-I/M cases. Because the no- I/M case has more running exhaust deterioration (relative to the I/M case), then the resulting no-I/M case also has more start exhaust deterioration (relative to the I/M case) when the ratio approach is applied. As a consequence, when modeling I/M in MOVES2014, there is a reduction in both running and start exhaust emissions relative to the equivalent no-I/M case. While the running exhaust reduction due to I/M is directly derived from EPA's assessment of the reference I/M program benefit,[17] the start exhaust reduction due to I/M estimated by the model is not directly derived from an I/M program evaluation. The start exhaust benefit (for I/M) is a mathematical artifact of the adjustment ratio method for start deterioration. It is not supported or validated by any real world data, and the resulting start exhaust benefit attributed to I/M is therefore uncertain.

3.9.3 Recommendations

There is one recommendation resulting from the review of the I/M program methods, and there is one correction identified for this evaluation element.

It is recommended that a suitable I/M program evaluation be completed in order to determine a start exhaust benefit due to I/M program implementation. This recommendation dovetails into the more general comment that the overall start exhaust deterioration method (using a simplified case of deterioration rate ratios as described in Section 3.2) is relatively uncertain. Any future examination of start exhaust benefit due to I/M should be defined consistently with the start exhaust methodology; more broadly, a direct evaluation of start exhaust deterioration—both in I/M areas and non-I/M areas—would be ideal.

A correction is proposed to the modeling parameters of I/M emission rates, no-I/M emission rates, and I/M adjustment factors. The core of the correction proposed is that I/M adjustment factors for the Reference I/M case should equal unity. Because the underlying I/M exhaust benefit is a variable factored into the development of the emission rate inputs into MOVES, this proposed correction to the I/M adjustment factors will subsequently require the recalculation of the I/M and no-I/M emission rates inputs of MOVES for consistency.

3.10 Operating Mode Functionality

3.10.1 Overview/Evaluation

There are multiple, significant functionality improvements and additions that the EPA incorporated into MOVES2014. These include, as previously discussed throughout this review, new features for the direct modeling of vehicle trips, new speciation capabilities, and new fuel modeling capabilities.

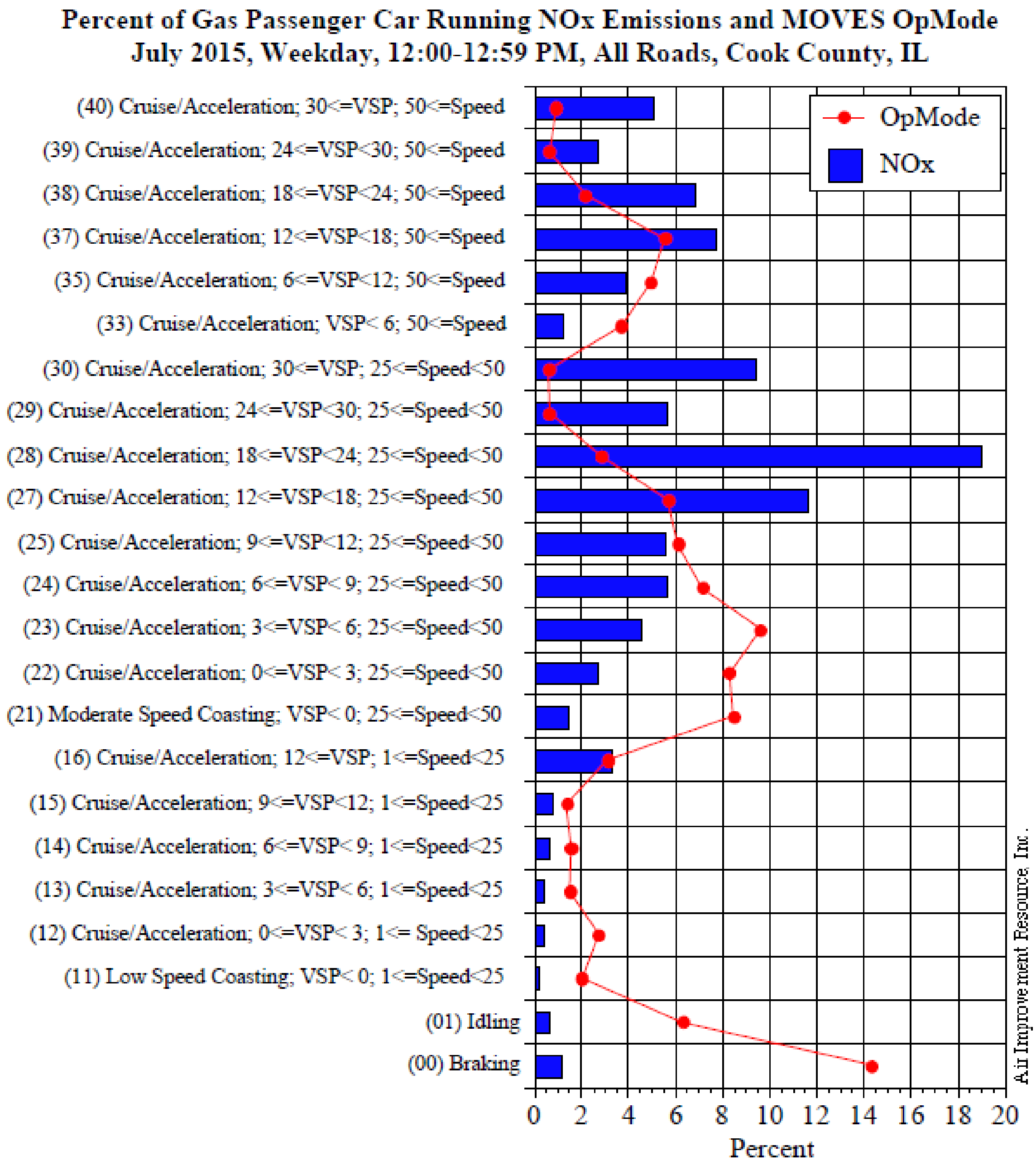
There was one key area of functionality that was removed from MOVES2014: the operating mode distribution resulting from the inventory calculations was eliminated from the data included in the model output. This feature, which was available in MOVES2010, would have enhanced the critical evaluation completed for this project.

This evaluation element discusses the issues around operating mode functionality in MOVES2014.

3.10.2 Evaluation

Previous studies have included the reporting of emission rates by operating mode and the frequency of operation time spent by operating mode.[63,64] An example of operating mode specific modeling results from MOVES is shown in Figure 3-6, which reports both the operating mode distribution (i.e., the proportion of operation type by mode) and the distribution of emissions by operating mode bin.

Figure 3-6
Example of Operating Mode Results from a Previous Version of MOVES



Source: "Review of the 2009 Draft Motor Vehicle Emissions Simulator (MOVES) Model," CRC Project: E-68a, November 2010.[64]

Instances where operating mode functionality could have improved the ability to complete evaluation tasks of this project are described below.

1. The hole-filling procedures of both heavy-duty diesel vehicles (see Section 3.1) and light-duty gasoline vehicles (see Section 3.2) often occurred at higher power ranges in the operating mode distributions for running exhaust. In order to evaluate the significance of these procedures—implemented to address gaps in the data record—it is important to document the frequency of occurrence and the potential emissions impact. It is not possible to assess the proportion of the inventory covered by the hole-filling procedures.

2. As described in Section 3.6, there were new heavy-duty duty cycles developed to broaden the operating mode characteristics included in MOVES2014 to improve the representation of operation characteristics at both slower speeds and higher speeds. There were no means to validate the overall changes in the new methods due to the lack of ability to obtain the operating mode distribution from the model output.

3. There are instances of trucks with specific vocations (e.g., refuse trucks and short-haul single unit trucks) where it would be informative to be able to examine operating mode distribution by vocation type for a comparative analysis and assessment.

3.10.3 Recommendations

There is a single recommendation on the issue of model functionality.

For future MOVES development, it is recommended that the functionality related to both the input and output of operating mode distribution data be allowed in all scales of inventory modeling. The three features listed below would be highly useful and desirable to support unique modeling cases, as well as to properly QA/QC model development and the correct processing of data inputs.

1. The model should include the capability to report the overall inventory operating mode distribution in the model output databases.

2. The model should include the capability to report emissions by operating mode so that the significance of individual operating mode contributions to the overall inventory can be assessed.

3. The model should include the ability to input a user-specified operating mode distribution so that a macro-scale inventory can be assessed using customized or standardized driving cycle.[*]

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[*] Notably, the capability to input a user-specified operating mode distribution does exist at the micro-scale, knowns as "project level" mode in MOVES2014. However, there are limits to project-level modeling in MOVES2014—for example, (1) modeling can only be completed for an individual hour, and (2) evaporative emission processes cannot be evaluated.

4. INVENTORY ANALYSES

Emissions inventories using the MOVES2014 model were developed and analyzed for three counties that span a range of ambient conditions, local control programs, and vehicle fleet characteristics. The inventories included the calendar years 2011, 2022, and 2050, and covered THC, NOx, $PM_{2.5}$, and CO. A base-case emissions inventory was developed for each county, and these were then evaluated with the use of sensitivity scenarios that measured the emissions impacts of alternative modeling assumptions as well as select changes in regulatory program parameters. The goals of the inventory analyses were twofold:

1. The Base Case inventory (i.e., the current regulatory context) was examined in order to assess the inventory trends under the inherently differing conditions of the three geographic locations; and

2. The sensitivity scenario inventories were defined and examined to test the consequences of a series of alternative modeling assumptions and control program changes.

The data from the inventory analyses provided invaluable context that factored into the critical evaluation (as discussed in Section 3 of this report) and provided the source of information for QA/QC checks and the inventory methods confirmation.

4.1 Analysis Methods

The inventory analyses were completed with the version of the MOVES2014 model released on October 23, 2014, with default databases dated October 21, 2014. Inventories were processed in County Domain mode. All exhaust and evaporative emissions processes were included in the inventory assessments. PM emissions from brake and tire wear were excluded. Thus, reported PM results are the sum of all exhaust processes only.

4.1.1 Location, Calendar Year and Season

Three counties were selected, based on the range of conditions they represented: Fulton County, Georgia; Maricopa County, Arizona; and Wayne County, Michigan. In each case, the county represents the largest county in its state when ranked by human population. The key county characteristics of these three locations are summarized in

Table 4-1. Distinct characteristics include the variation in forecasted growth levels, vehicle fleet makeup, local control programs (I/M and fuel), and ambient temperature.

Table 4-1
Summary of County Characteristics of the Three Modeling Locations

Parameter	Fulton County (GA)	Maricopa County (AZ)	Wayne County (MI)
Metropolitan Statistical Area	Atlanta-Sandy Springs-Roswell	Phoenix-Mesa-Glendale	Detroit-Warren-Livonia
Human Population (2011)	949,599	3,880,244	1,802,096
County Population Rank within State (2011)	1	1	1
Area (mi^2)	534	9,224	673
Mean Temperature: July Min/Max (ºF) January Min/Max (ºF)	 71/91 29/48	 80/105 40/67	 69/89 15/29
Vehicle Population (2011)	807,939	2,787,358	1,214,732
Vehicle Miles Traveled (2011, Annual)	12,221,921,568	32,442,909,320	16,694,871,362
Forecasted Growth in On-Road Activity	Moderate	High	Low
Vehicle Class VMT Splits (2011)	Greater light-duty proportion (than the national average)	National-average light and heavy-duty proportion; motorcycle usage twice the national average	National-average light and heavy-duty proportion
Average Age, Light-Duty Vehicle (2011, Years)	8.4	8.6	7.8
Rural Interstate Roadways	No	Yes	No
I/M Program	Yes	Yes	No
Gasoline Program	Conventional gasoline with local summer season RVP limit	Reformulated gasoline with local winter season RVP limit	Conventional gasoline with local summer season RVP limit

Notably, Maricopa County is a significantly large domain (by area).* The presence (or absence) of rural interstate roadways plays out in the inventory analysis as heavy-duty diesel hoteling is predominately allocated to rural interstates; Maricopa County has significant rural interstate mileage.

* Maricopa County is approximately the size of the State of New Hampshire and is larger than four other states (Rhode Island, Delaware, Connecticut, and New Jersey).

The three calendar years of evaluation (2011, 2022, and 2050) were selected for the reasons noted below.

- 2011 represents the current activity base year for the MOVES2014 model (i.e., the most recent calendar year that is not a projection), and is the base year used in current 8-hour ozone State Implementation Plan (SIP) efforts.

- 2050 was selected to represent a calendar year for which the sensitivity of the MOVES model outputs to changes in input parameters could be evaluated on an in-use fleet anticipated to be comprised only of vehicles certified on the most recently adopted federal emissions and fuel standards (e.g., Tier 3).

- 2022 was identified as a suitable near-term forecast year for evaluation and is also the year by which the Renewable Fuels Standard (RFS2) is targeted to be fully enacted.

The inventory analyses include both winter and summer season evaluations. Winter was modeled as "January," and summer was modeled as "July." Both weekend and weekday modeling was completed. Results are reported for an "Average Summer Day" (i.e., a proportional combination of weekdays and weekend days in July) and an "Average Winter Day" (i.e., a proportional combination of weekdays and weekend days in January).

4.1.2 Input Data and Processing

Location-specific, county-level input was used in the inventory analyses obtained from the EPA's National Emission Inventory (NEI) and other local agency resources. Model defaults were used as a last resort for any input not otherwise available. Data accuracy checks were performed, and some corrections were made.

Version 2 of the 2011 NEI served as the foundation for MOVES2014 inputs at the county level for this project.[65] These inputs are a compilation maintained by the EPA and submitted by local and state planning agencies. The county databases represent calendar year 2011 conditions.

The 2011 NEI data were supplemented by the data resources listed below for each location. Deference (over the NEI) was given to modeling input obtained from local and state agencies as available.

- Fulton County (Georgia) – The recent ozone and PM SIPs provided vehicle age data, VMT, and vehicle populations (for 2008 and 2024) and I/M program specifications.[66,67] The I/M specifications were modified to include FFVs—an updated vehicle type requirement specific to MOVES2014.[*] The model-year window of vehicles subject to I/M was observed to be incorrect for the 2024 input

[*] The FFV entries in the I/M record were missing.

data and was corrected. The activity data were linearly extrapolated/interpolated to represent the calendar years of evaluation (2011, 2022 and 2050).

- Maricopa County (Arizona) – The local planning agency declined to provide SIP modeling inputs because the current SIP was under EPA review and not approved at the time of the request; NEI inputs were therefore used in most instances. Projected vehicle population and VMT assumptions for 2022 and 2050 were estimated from the corresponding 2011 NEI values using the following data resources: (1) MOVES national fleet defaults, (2) US human population projections (from the U.S. Census)[68] and (3) Maricopa County human population projection to 2050 from the Arizona State Demographer's Office.[69] [*]

- Wayne County (Michigan) – The local planning agency provided electronic fleet characteristics and activity data for the years from 2010 to 2040 (in increments of five years).[70] These activity and age distribution data superseded the NEI values; 2050 was estimated by linear extrapolation.

4.1.3 Base Case Fuel Assumptions

All three study locations rely on MOVES defaults for fuel formulation data. These data were reviewed, and some corrections were made. The sensitivity scenarios completed include fuel program changes, and the impact of the sensitivity scenarios is thereby relative to the Base Case inventory assumptions for each location. The Base Case fuel assumptions are summarized in Tables 4-2, 4-3, and 4-4 for Fulton, Maricopa and Wayne Counties, respectively.

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[*] Activity projections were completed at the individual MOVES source type level. The steps for the activity data projection included (1) assessing Maricopa County ownership rates (i.e., number of vehicles per population) and VMT per vehicle rates represented by the 2011 base year data record, (2) forecasting the 2022 and 2050 ownership and VMT/ vehicle rates for Maricopa County by applying the MOVES2014 national trends to the local rates for 2011, and (3) calculating the vehicle population and VMT for 2022 and 2050 from the projected Maricopa County ownership and VMT/vehicle rates combined with the local human population projection for the county.

Table 4-2 Fulton County (GA) Base Case Fuel Assumptions	
Local fuel formulation data:	No
MOVES fuel region ID:	17000000
Changes made to MOVES default fuel inputs:	None
Summer fuel:	Conventional gasoline, local 7 PSI RVP limit
Winter fuel:	Conventional gasoline
E10 RVP waiver:	Yes
Ethanol Blend Market Share: 2011 2022 2050	 9% E0, 91% E10 88% E10, 12% E15 78% E10, 22% E15
E85 Usage Rate in FFVs, 2011/2022/2050	0.3%/18%/21%

Table 4-3 Maricopa County (AZ) Base Case Fuel Assumptions	
Local fuel formulation data:	No
MOVES fuel region ID:	1570011000
Changes made to MOVES default fuel inputs:	Corrected E15 market share (2022 & 2050);* corrected winter season RVP to match local requirement
Summer fuel:	Reformulated gasoline
Winter fuel:	Reformulated gasoline, local 9 PSI RVP limit
E10 RVP waiver:	Yes
Ethanol Blend Market Share: 2011 2022 2050	 100% E10 100% E10 100% E10
E85 Usage Rate in FFVs, 2011/2022/2050	0.3%/18%/21%

* The MOVES2014 default for this fuel region had 100% market share of E15 in 2022 and 2050, which EPA indicated was an error. There is no regulatory mechanism for marketing E15 in Maricopa County (the reformulated gasoline regulation is patterned after California's Cleaner Burning gasoline regulation) and the market share of E15 in the Base Case was set to 0 percent.

Table 4-4 **Wayne County (MI) Base Case Fuel Assumptions**	
Local fuel formulation data:	No
MOVES fuel region ID:	270000000
Changes made to MOVES default fuel inputs:	Corrected T90 specification (Winter 2011)*
Summer fuel:	Conventional gasoline, local 7 PSI RVP limit
Winter fuel:	Conventional gasoline
E10 RVP waiver:	Yes
Ethanol Blend Market Share: 2011 2022 2050	 10% E0, 90% E10 87% E10, 13% E15 77% E10, 23% E15
E85 Usage Rate in FFVs, 2011/2022/2050	0.3%/18%/21%

4.1.4 Inventory Scenarios

Inventory scenarios included the Base Case (current regulatory context) and nine sensitivity scenarios, as summarized in Table 4-5. Sensitivity scenarios were selected to test varying modeling assumptions and local control programs. Many of the sensitivity scenarios focus on fuel parameter evaluations, as one of the major updates to MOVES involved the modeling of fuel effects on emissions.

Notes on the specifics of each scenario are provided below.

RVP Sensitivity - Sensitivity Scenarios 1 and 2 examined the inventory impacts of a 1 PSI increase in RVP. Scenario 1 retains the MOVES assumptions for the interrelationship between gasoline parameters when RVP changes: specifically minus 2.57 and minus 2.27 degree changes in T50 and T90, respectively, as shown in Table 3-13. Scenario 2 is a straight 1 psi RVP change with no other parameter changes. Scenarios 1 and 2 were evaluated for the summer season only in Fulton and Wayne Counties; Scenarios 1 and 2 were evaluated for both winter and summer seasons for Maricopa County.†

* As described in Section 3.5, some instances of questionable T90 values were found in the default fuel formulation data as part of the review completed. Winter 2011 T90 values for the Wayne County gasoline formulations were switched from 281.6 and 279.1 degrees Fahrenheit (for E0 and E10, respectively) to 322.3 and 319.8 degrees.

† Winter season RVP for Maricopa County was included as a sensitivity case here as the only US location with a winter RVP (maximum of 9 PSI set as part of the CO Maintenance Plan) that falls within the range used to develop MOVES2014 fuel corrections (maximum RVP of 10.3 PSI). The range of winter season RVP in the remainder of the US falls within the range of 12 to 16 PSI.

Table 4-5 Inventory Scenarios	
Inventory Scenario	**Description**
Base Case (Scenario 0)	Current regulatory context using local inputs
Sensitivity Scenario 1	+1 PSI RVP change with Fuel Wizard relationships
Sensitivity Scenario 2	+1 PSI RVP change
Sensitivity Scenario 3	100% E10
Sensitivity Scenario 4	100% E15
Sensitivity Scenario 5	100% E15 with updated T50 relationship
Sensitivity Scenario 6	Add or remove I/M (relative to Base Case)
Sensitivity Scenario 7	Add startup NOx emissions for SCR equipped diesel trucks
Sensitivity Scenario 8	Add or remove reformulated gasoline (relative to Base Case)
Sensitivity Scenario 9	Change local passenger car and light truck mix to national average

Ethanol Blend Market Share – Sensitivity Scenarios 3, 4, and 5 examined the shift in gasoline market share to 100% of either E10 or E15. Scenarios 3 and 4 relied on the MOVES2014 default fuel formulations for each location. Scenario 5 is the same as Scenario 4 except that a revised T50 specification for E15 was used.*

I/M Program – Sensitivity Scenario 6 examined the inventory impact of adding or removing the local I/M program. For Fulton and Maricopa Counties, the I/M program of the Base Case was removed. For Wayne County, EPA's reference case I/M program consisting of OBD MIL and gas cap checks of light-duty gasoline vehicles was added for Scenario 6.

Add SCR NOx Startup Exhaust – Sensitivity Scenario 7 added NOx startup exhaust impacts for Class 8 heavy-duty diesel vehicles equipped with SCR. As described in Section 3.1, these emissions (not currently part of MOVES2014) occur prior to complete warm-up of the emission control equipment of 2010 and later model year heavy-duty diesel trucks. The method for this scenario follows that developed by CARB for EMFAC2014.[71] Specifically, the method used the local fleet population as input and then assumed the start frequency and rates shown in Table 4-6.

* The alternate T50 specification was identified as part of the critical evaluation (see Section 3.4) and is defined as a linear function of the T50 specification for E10 used in blending.

Table 4-6 Modeling Assumptions for NOx Startup Exhaust from SCR-Equipped Class 8 Heavy-Duty Diesel Vehicles [71]			
Service Type	**Type of Start**	**Starts (per vehicle per day)**	**NOx Start Exhaust Emission Rate (grams/trip)**
Long-Haul	Cold Start	1	29.8
	Warm Start	1.53	14.7
Short-Haul	Cold Start	1	29.8
	Warm Start	1.04	14.7

Reformulated Gasoline – Sensitivity Scenario 8 examined the impact of adding or removing reformulated gasoline. For Maricopa County, this replaced the default fuel formulation data with those of the surrounding conventional gasoline specifications. For Fulton and Wayne Counties, this replaced the default fuel formulation with those assumed for reformulated gasoline within the same PADD region.*

Passenger Car and Light Truck Mix – Sensitivity Scenario 9 examined the impact of changing the local mix of passenger cars (PCs) and light-duty trucks on the emission inventory. The local mix of cars and trucks was modified to that of the national average. The pertinent mix of vehicles is summarized in Table 4-7.

Table 4-7 Passenger Car Share of the Light Duty Fleet, Vehicle Population			
Location	**2011**	**2022**	**2050**
Fulton County (GA)	64%	64%	64%
Maricopa County (AZ)	82%	82%	82%
Wayne County (MI)	59%	59%	59%
National Average	60%	60%	60%

4.2 Base Case Inventory Results

The Base Case inventory and activity data results are reported for the three geographic locations of Fulton County (Georgia), Maricopa County (Arizona) and Wayne County (Michigan) for the three years of 2011, 2022, and 2050. Inventories cover the criteria pollutants of THC, NOx, $PM_{2.5}$, and CO. The activity data cover VMT, trips, hours of operation and vehicle counts. The Base Case represents the current regulatory context for each location.

* MOVES2014 default fuel formulation data (i.e., those that define the fuel regions) are aggregates at the PADD region resolved by regulatory requirements (i.e., reformulated, conventional, etc.)

For Fulton County, Base Case inventory results are presented in Table 4-8, and the activity data are presented in Table 4-9. Time series plots by season are presented in a series of figures, as listed below.

- Figure 4-1. Fulton County (GA) Summer, VMT
- Figure 4-2. Fulton County (GA) Summer, Vehicles
- Figure 4-3. Fulton County (GA) Summer, THC (Exhaust & Evaporative)
- Figure 4-4. Fulton County (GA) Summer, THC (Exhaust)
- Figure 4-5. Fulton County (GA) Summer, THC (Evaporative)
- Figure 4-6. Fulton County (GA) Summer, NOx
- Figure 4-7. Fulton County (GA) Summer, $PM_{2.5}$
- Figure 4-8. Fulton County (GA) Summer, CO
- Figure 4-9. Fulton County (GA) Winter, VMT
- Figure 4-10. Fulton County (GA) Winter, Vehicles
- Figure 4-11. Fulton County (GA) Winter, THC (Exhaust & Evaporative)
- Figure 4-12. Fulton County (GA) Winter, THC (Exhaust)
- Figure 4-13. Fulton County (GA) Winter, THC (Evaporative)
- Figure 4-14. Fulton County (GA) Winter, NOx
- Figure 4-15. Fulton County (GA) Winter, $PM_{2.5}$
- Figure 4-16. Fulton County (GA) Winter, CO

Table 4-8 Fulton County (GA) Base Case Inventory Results (Tons per Average Day)												
		Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			Total On-Road
Year, Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.		Exhaust	Crank-case	Idle / APU	
2011, Summer	THC	12.122	6.316	0.875	0.232	0.112	0.131	0.191	1.192	0.040	0.177	21.387
	CO	232.028	0.000	20.442	0.000	1.540	0.000	3.585	6.177	0.067	0.291	264.129
	NOx	24.082	0.000	2.018	0.000	0.059	0.000	0.253	14.878	0.000	0.592	41.883
	$PM_{2.5}$	0.254	0.000	0.013	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.134
2011, Winter	THC	14.656	3.175	0.769	0.120	0.053	0.058	0.194	1.146	0.038	0.167	20.376
	CO	187.031	0.000	17.120	0.000	0.749	0.000	2.277	5.192	0.058	0.274	212.701
	NOx	24.395	0.000	2.094	0.000	0.038	0.000	0.225	16.887	0.000	0.716	44.355
	$PM_{2.5}$	0.537	0.000	0.028	0.000	0.002	0.000	0.003	0.608	0.152	0.009	1.338
2022, Summer	THC	3.677	3.502	0.265	0.121	0.087	0.153	0.050	0.379	0.006	0.146	8.384
	CO	133.146	0.000	11.290	0.000	1.258	0.000	1.714	2.327	0.010	0.272	150.015
	NOx	5.700	0.000	0.564	0.000	0.061	0.000	0.077	4.151	0.000	0.495	11.048
	$PM_{2.5}$	0.207	0.000	0.010	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.380
2022, Winter	THC	5.265	2.008	0.248	0.072	0.039	0.067	0.089	0.472	0.006	0.137	8.404
	CO	95.284	0.000	8.841	0.000	0.580	0.000	0.994	2.014	0.009	0.256	107.978
	NOx	6.306	0.000	0.579	0.000	0.039	0.000	0.068	4.647	0.000	0.598	12.237
	$PM_{2.5}$	0.257	0.000	0.012	0.000	0.001	0.000	0.002	0.105	0.033	0.003	0.412
2050, Summer	THC	1.114	2.189	0.131	0.103	0.114	0.206	0.017	0.290	0.000	0.160	4.325
	CO	57.748	0.000	6.164	0.000	1.638	0.000	0.834	2.078	0.000	0.306	68.768
	NOx	1.425	0.000	0.202	0.000	0.081	0.000	0.019	2.617	0.000	0.540	4.884
	$PM_{2.5}$	0.146	0.000	0.013	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.219
2050, Winter	THC	3.391	1.588	0.144	0.074	0.052	0.093	0.084	0.454	0.000	0.151	6.029
	CO	50.406	0.000	5.776	0.000	0.758	0.000	0.487	1.874	0.000	0.288	59.588
	NOx	2.559	0.000	0.237	0.000	0.051	0.000	0.018	2.973	0.000	0.653	6.491
	$PM_{2.5}$	0.147	0.000	0.012	0.000	0.001	0.000	0.001	0.034	0.008	0.003	0.207

Table 4-9 Fulton County (GA) Base Case Activity Data (per Average Day)								
Year, Season	**Parameter**	**Light-Duty Gasoline**	**Heavy-Duty Gasoline**	**Motorcycle**	**Light-Duty Diesel**	**Heavy-Duty Diesel**	**Hoteling (Idling/APU)**	**Total On-Road**
2011, Summer	Vehicles	1,483,536	35,173	20,955	6,011	32,098	0	1,577,771
	VMT	31,840,999	695,567	92,509	249,938	1,912,746	0	34,791,759
	Trips	3,957,023	92,378	7,937	32,606	153,372	0	4,243,315
	Hours	1,898,294	43,996	5,438	7,376	52,095	3,059	2,010,258
2011, Winter	Vehicles	1,483,536	35,173	20,955	6,011	32,098	0	1,577,771
	VMT	26,000,636	571,444	38,855	202,824	1,700,742	0	28,514,501
	Trips	3,957,023	92,378	7,937	32,606	153,372	0	4,243,315
	Hours	1,544,393	35,990	2,275	5,967	46,001	2,882	1,637,508
2022, Summer	Vehicles	1,771,661	40,609	25,847	9,473	39,375	0	1,886,963
	VMT	36,034,745	755,773	105,044	397,521	2,188,837	0	39,481,919
	Trips	4,726,031	107,669	9,790	51,155	188,726	0	5,083,371
	Hours	2,145,932	50,340	6,175	11,724	59,729	3,265	2,277,164
2022, Winter	Vehicles	1,771,661	40,609	25,847	9,473	39,375	0	1,886,963
	VMT	29,420,547	622,030	44,119	324,326	1,942,015	0	32,353,038
	Trips	4,726,031	107,669	9,790	51,155	188,726	0	5,083,371
	Hours	1,745,635	41,199	2,584	9,533	52,624	3,076	1,854,650
2050, Summer	Vehicles	2,516,332	56,828	38,299	14,788	54,574	0	2,680,820
	VMT	46,930,297	977,075	136,951	550,312	2,824,713	0	51,419,348
	Trips	6,713,594	151,346	14,506	79,710	262,538	0	7,221,694
	Hours	2,794,562	65,419	8,051	16,228	77,179	3,790	2,965,229
2050, Winter	Vehicles	2,516,332	56,828	38,299	14,788	54,574	0	2,680,820
	VMT	38,309,236	804,492	57,521	449,331	2,503,392	0	42,123,973
	Trips	6,713,594	151,346	14,506	79,710	262,538	0	7,221,694
	Hours	2,272,879	53,552	3,368	13,206	67,921	3,571	2,414,498

Figure 4-1
Fulton County (GA) VMT
Base Case (Miles per Average Summer Day)

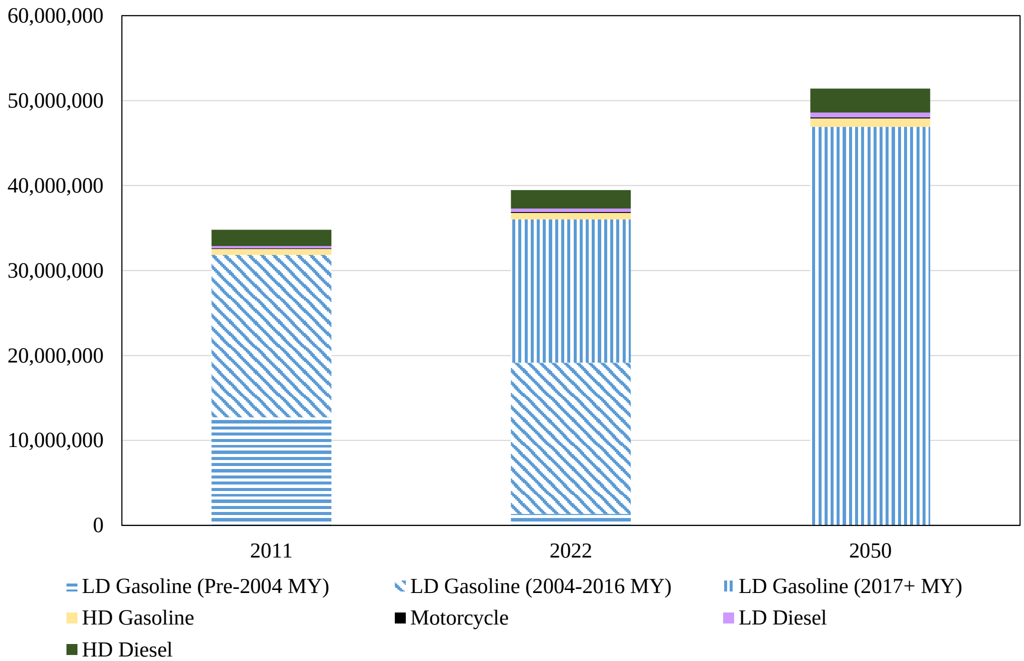


Figure 4-2
Fulton County (GA) Vehicle Population
Base Case (Summer Average Day)

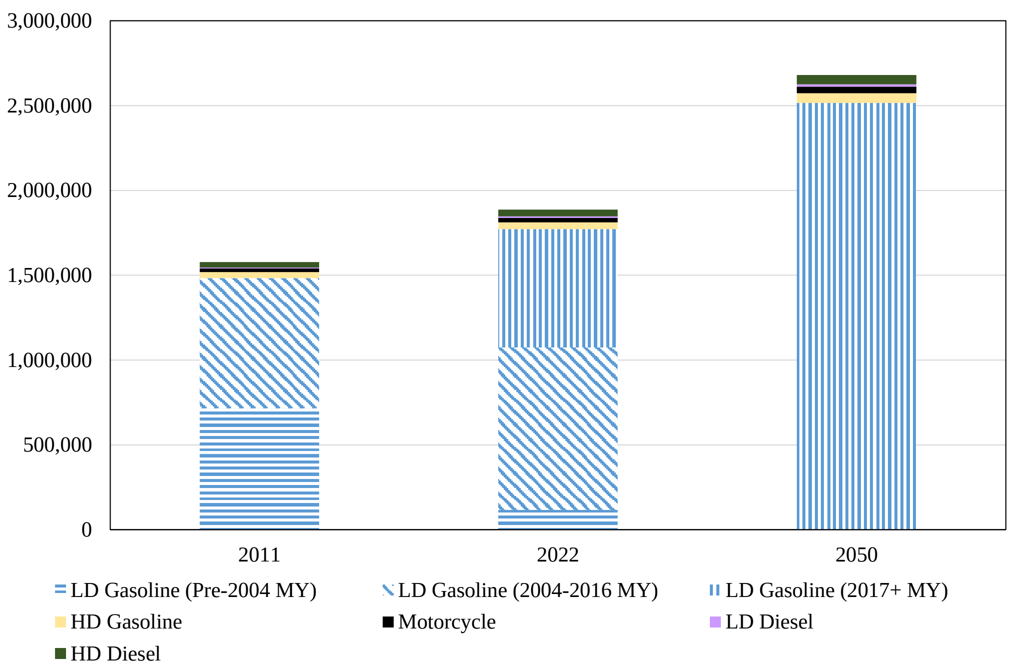


Figure 4-3
Fulton County (GA) Total Hydrocarbons (Exhaust & Evaporative)
Base Case (Tons per Summer Average Day)

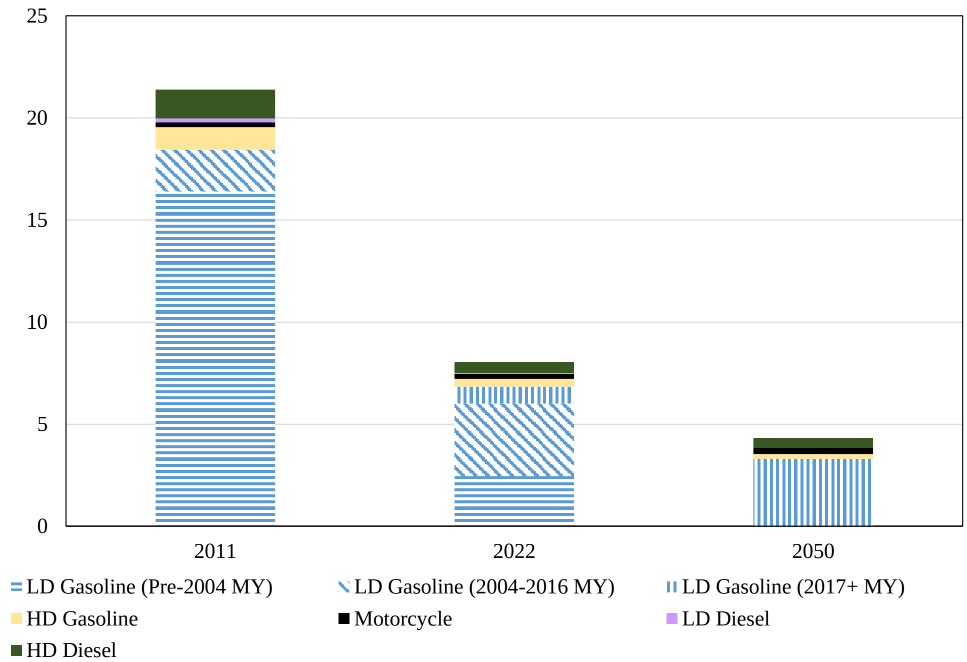


Figure 4-4
Fulton County (GA) Total Hydrocarbons (Exhaust)
Base Case (Tons per Summer Average Day)

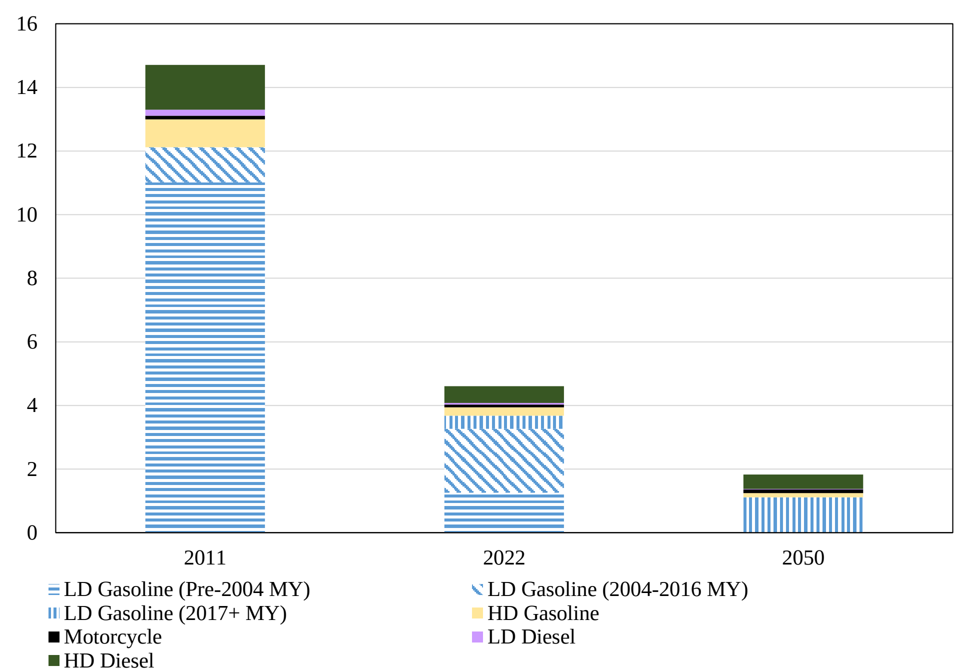


Figure 4-5
Fulton County (GA) Total Hydrocarbons (Evaporative)
Base Case (Tons per Summer Average Day)

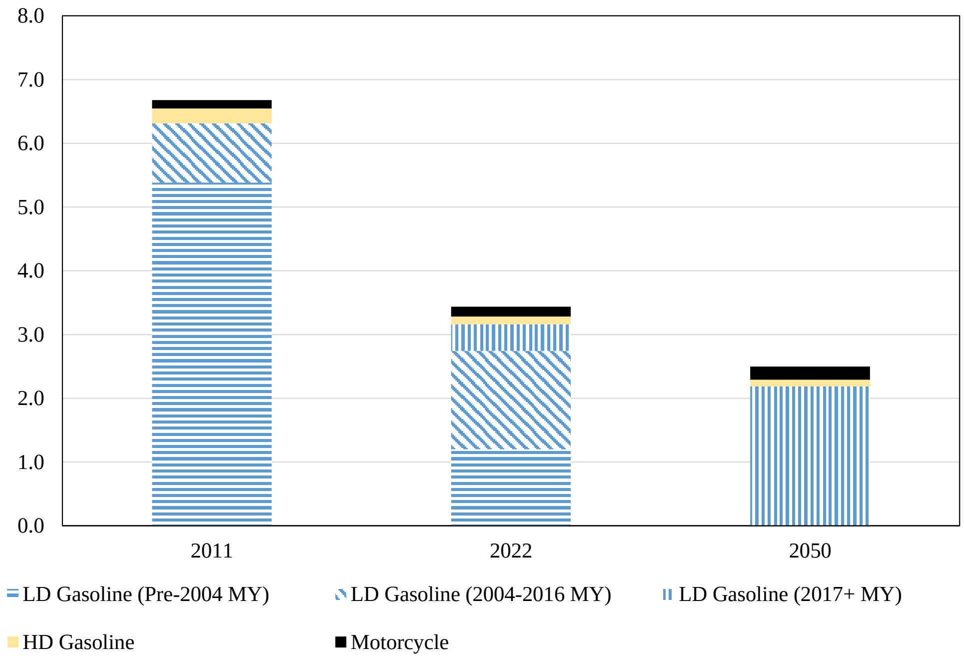


Figure 4-6
Fulton County (GA) Oxides of Nitrogen
Base Case (Tons per Summer Average Day)

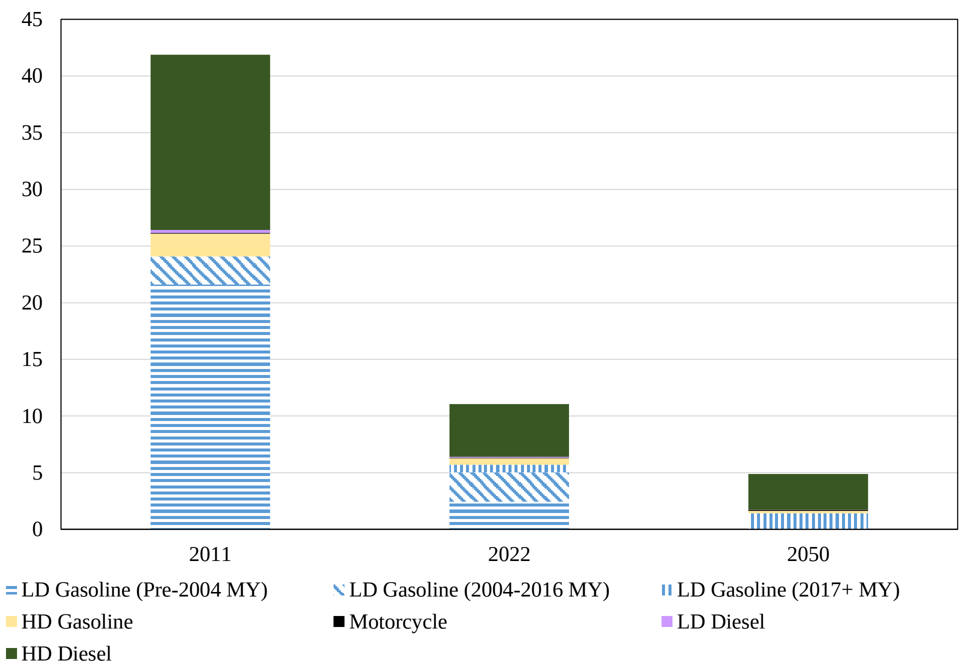


Figure 4-7
Fulton County (GA) $PM_{2.5}$
Base Case (Tons per Summer Average Day)

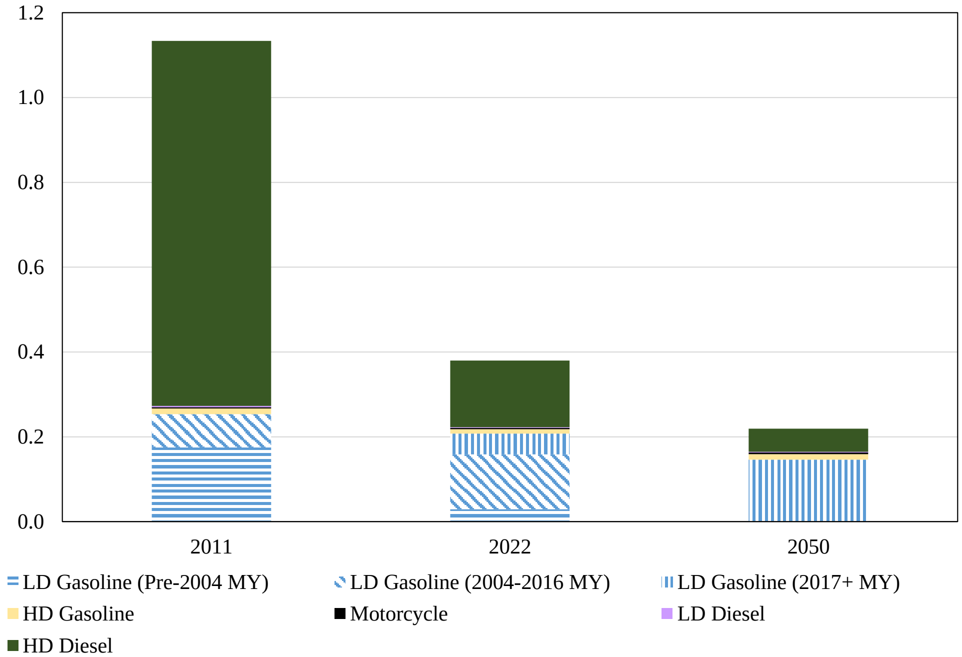


Figure 4-8
Fulton County (GA) Carbon Monoxide
Base Case (Tons per Summer Average Day)

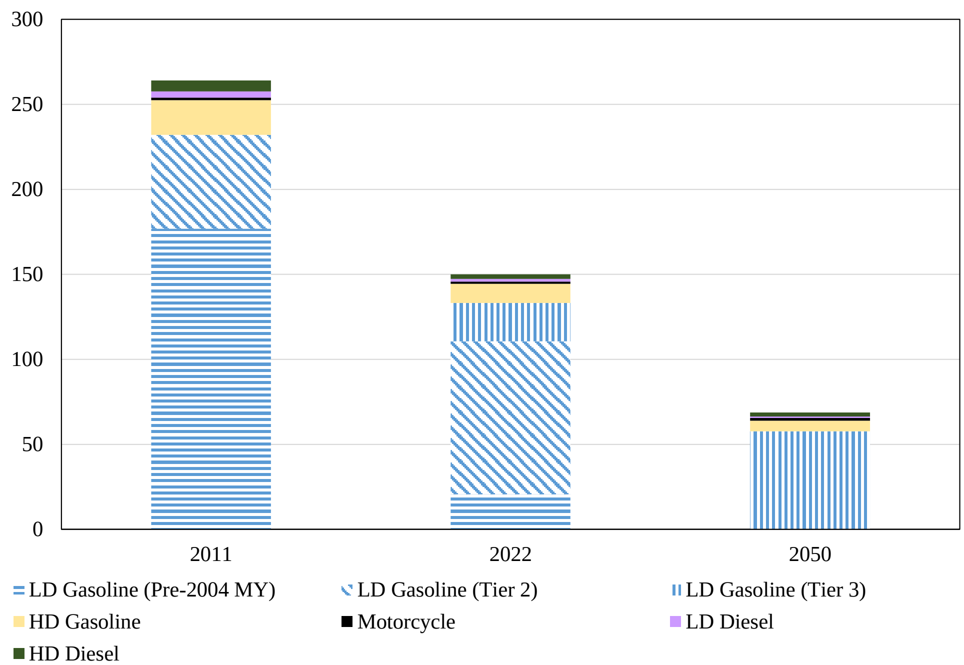


Figure 4-9
Fulton County (GA) VMT
Base Case (Miles per Winter Average Day)

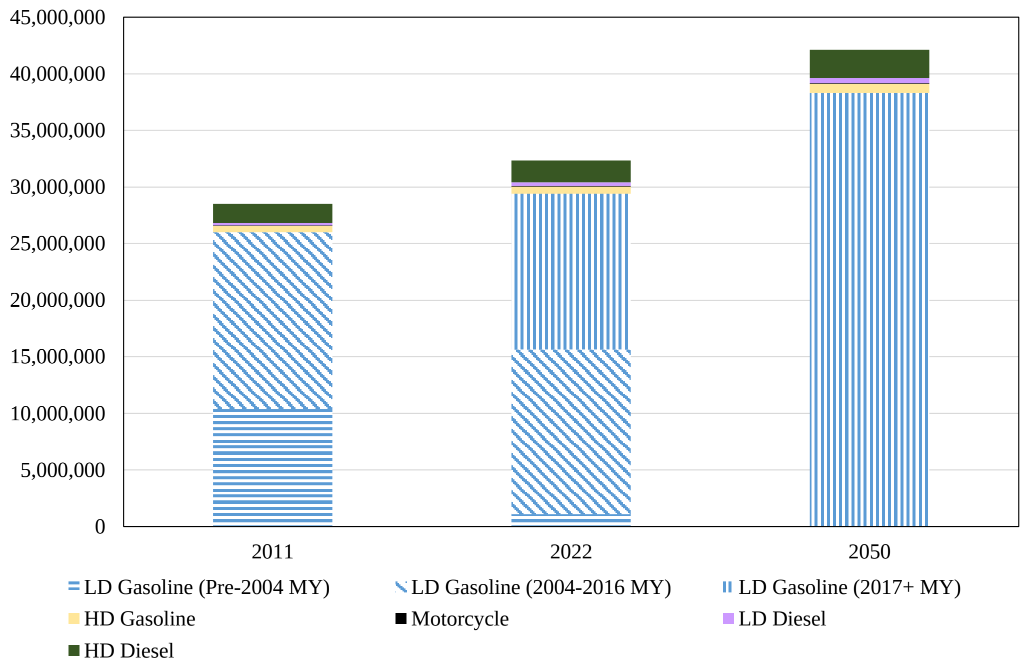


Figure 4-10
Fulton County (GA) Vehicle Population
Base Case (Winter Average Day)

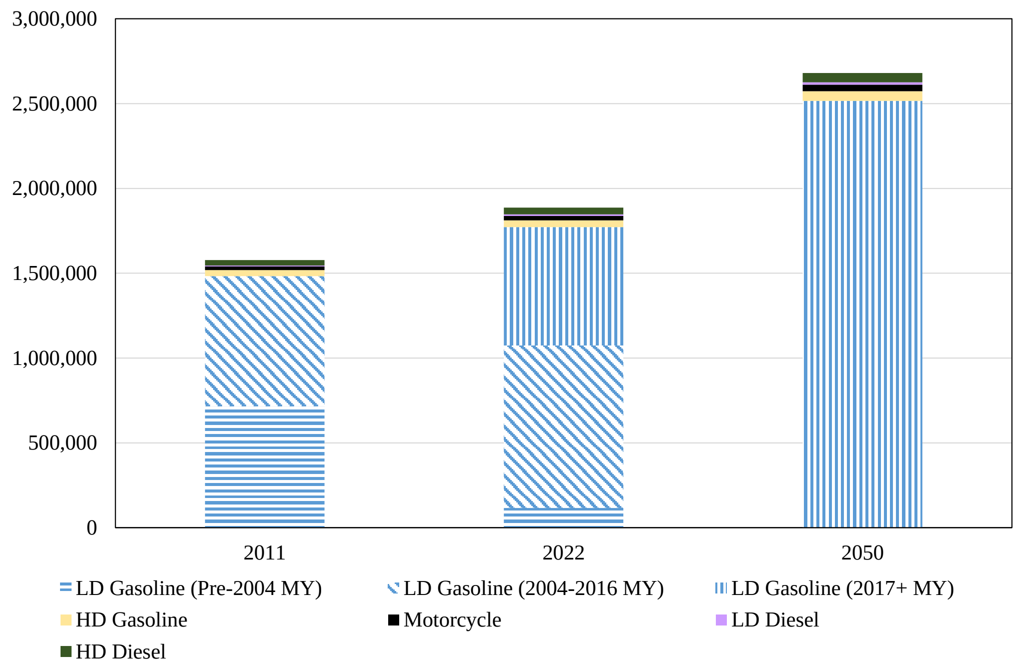


Figure 4-11
Fulton County (GA) Total Hydrocarbons (Exhaust & Evaporative)
Base Case (Tons per Winter Average Day)

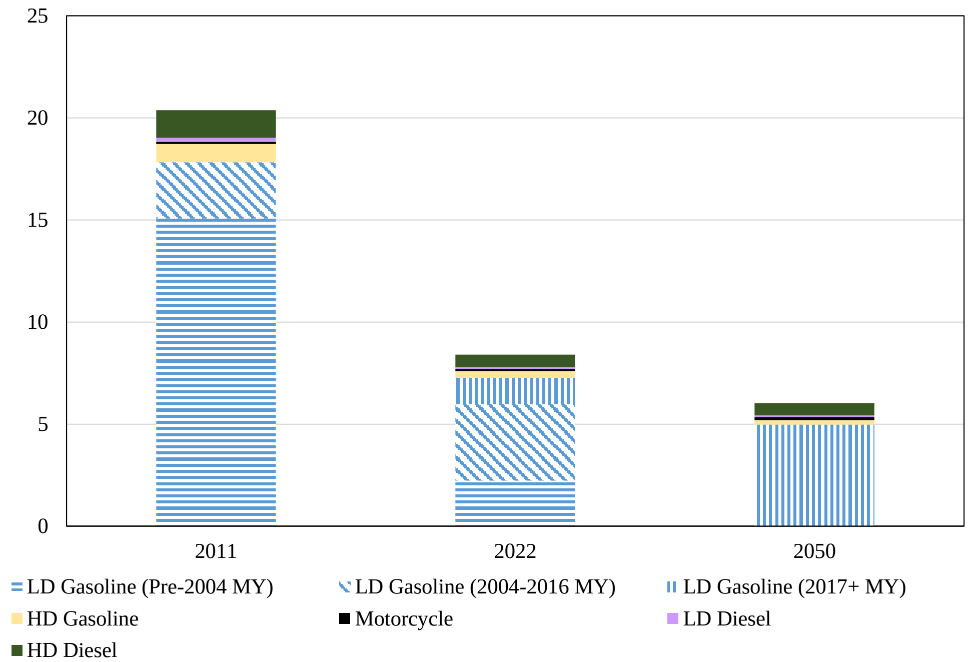


Figure 4-12
Fulton County (GA) Total Hydrocarbons (Exhaust)
Base Case (Tons per Winter Average Day)

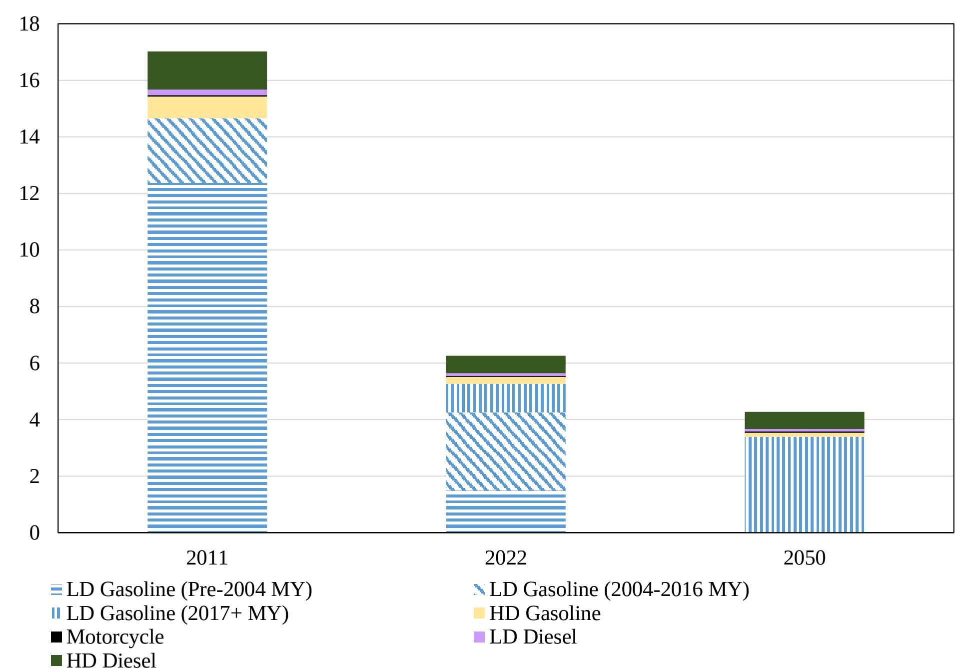


Figure 4-13
Fulton County (GA) Total Hydrocarbons (Evaporative)
Base Case (Tons per Winter Average Day)

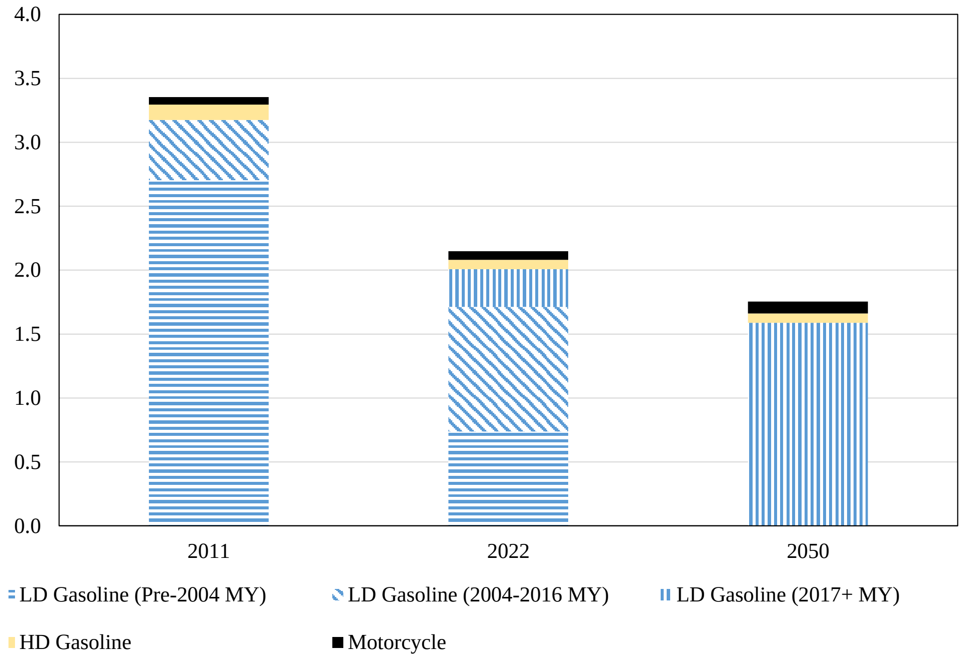


Figure 4-14
Fulton County (GA) Oxides of Nitrogen
Base Case (Tons per Winter Average Day)

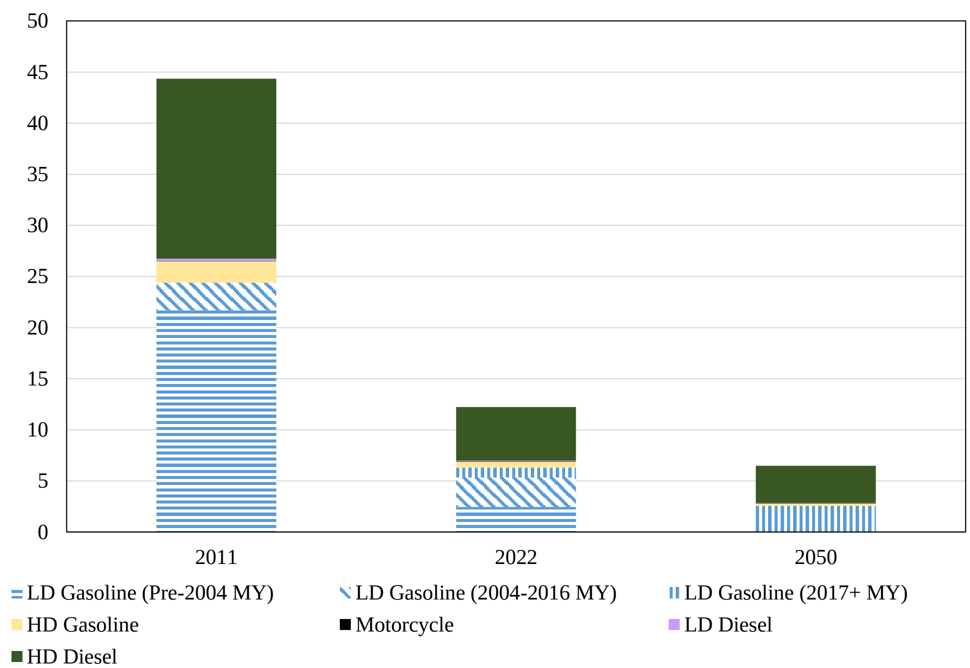


Figure 4-15
Fulton County (GA) $PM_{2.5}$
Base Case (Tons per Winter Average Day)

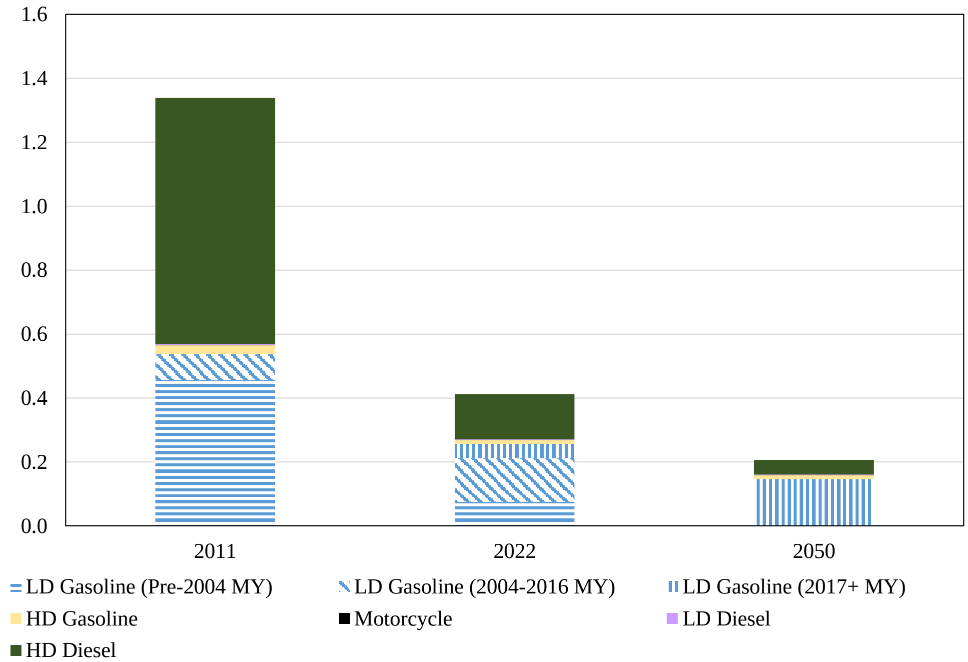
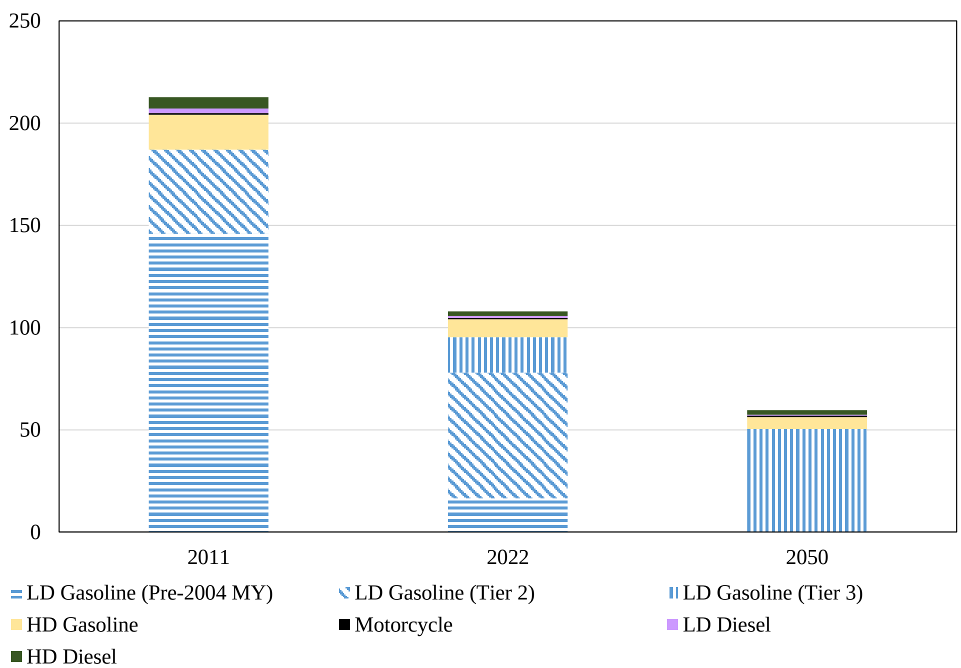


Figure 4-16
Fulton County (GA) Carbon Monoxide
Base Case (Tons per Winter Average Day)



For Maricopa County, Base Case inventory results are presented in Table 4-10, and the activity data are presented in Table 4-11. Time series plots by season are then presented in a series of figures, as listed below.

- Figure 4-17. Maricopa County (AZ) Summer, VMT
- Figure 4-18. Maricopa County (AZ) Summer, Vehicles
- Figure 4-19. Maricopa County (AZ) Summer, THC (Exhaust & Evaporative)
- Figure 4-20. Maricopa County (AZ) Summer, THC (Exhaust)
- Figure 4-21. Maricopa County (AZ) Summer, THC (Evaporative)
- Figure 4-22. Maricopa County (AZ) Summer, NOx
- Figure 4-23. Maricopa County (AZ) Summer, $PM_{2.5}$
- Figure 4-24. Maricopa County (AZ) Summer, CO
- Figure 4-25. Maricopa County (AZ) Winter, VMT
- Figure 4-26. Maricopa County (AZ) Winter, Vehicles
- Figure 4-27. Maricopa County (AZ) Winter, THC (Exhaust & Evaporative)
- Figure 4-28. Maricopa County (AZ) Winter, THC (Exhaust)
- Figure 4-29. Maricopa County (AZ) Winter, THC (Evaporative)
- Figure 4-30. Maricopa County (AZ) Winter, NOx
- Figure 4-31. Maricopa County (AZ) Winter, $PM_{2.5}$
- Figure 4-32. Maricopa County (AZ) Winter, CO

Table 4-10 Maricopa County (AZ) Base Case Inventory Results (Tons per Average Day)												
Year, Season	**Pollutant**	**Light-Duty Gasoline**		**Heavy-Duty Gasoline**		**Motorcycle**		**Light-Duty Diesel**	**Heavy-Duty Diesel**			**Total On-Road**
		Exhaust	**Evap.**	**Exhaust**	**Evap.**	**Exhaust**	**Evap.**		**Exhaust**	**Crank-case**	**Idle / APU**	
2011, Summer	THC	23.545	28.243	1.385	0.637	1.783	1.930	0.506	4.009	0.159	0.657	62.854
	CO	519.282	0.000	39.002	0.000	23.645	0.000	9.280	19.679	0.324	1.031	612.243
	NOx	51.457	0.000	3.655	0.000	1.167	0.000	0.579	61.402	0.048	2.680	120.988
	$PM_{2.5}$	0.594	0.000	0.036	0.000	0.038	0.000	0.009	2.588	0.619	0.039	3.923
2011, Winter	THC	28.473	13.573	1.385	0.338	1.728	1.268	0.545	4.323	0.170	0.694	52.496
	CO	443.357	0.000	36.875	0.000	25.197	0.000	7.193	20.082	0.313	1.114	534.132
	NOx	53.191	0.000	4.060	0.000	1.447	0.000	0.560	71.848	0.056	3.155	134.316
	$PM_{2.5}$	1.011	0.000	0.057	0.000	0.045	0.000	0.009	2.734	0.654	0.041	4.550
2022, Summer	THC	11.483	17.568	0.545	0.495	1.505	2.186	0.174	1.198	0.011	0.760	35.923
	CO	380.394	0.000	23.663	0.000	21.252	0.000	5.157	6.503	0.026	1.421	438.416
	NOx	18.382	0.000	1.405	0.000	1.342	0.000	0.249	17.566	0.003	2.961	41.908
	$PM_{2.5}$	0.456	0.000	0.034	0.000	0.047	0.000	0.006	0.312	0.136	0.014	1.004
2022, Winter	THC	13.531	9.598	0.528	0.289	1.428	1.527	0.258	1.426	0.012	0.802	29.397
	CO	305.402	0.000	21.526	0.000	22.620	0.000	3.556	6.608	0.023	1.503	361.238
	NOx	20.111	0.000	1.572	0.000	1.660	0.000	0.237	20.488	0.003	3.486	47.557
	$PM_{2.5}$	0.578	0.000	0.038	0.000	0.047	0.000	0.006	0.329	0.144	0.015	1.156
2050, Summer	THC	4.481	12.469	0.437	0.614	2.356	3.375	0.071	1.690	0.001	1.416	26.910
	CO	212.844	0.000	20.044	0.000	33.500	0.000	3.204	9.539	0.002	2.692	281.825
	NOx	6.032	0.000	1.006	0.000	2.169	0.000	0.081	21.571	0.000	5.493	36.352
	$PM_{2.5}$	0.363	0.000	0.054	0.000	0.076	0.000	0.006	0.304	0.185	0.024	1.013
2050, Winter	THC	8.524	8.545	0.436	0.394	2.226	2.425	0.231	2.075	0.001	1.494	26.352
	CO	188.311	0.000	20.073	0.000	35.621	0.000	2.182	9.783	0.001	2.842	258.814
	NOx	8.941	0.000	1.200	0.000	2.681	0.000	0.078	25.281	0.000	6.466	44.646
	$PM_{2.5}$	0.397	0.000	0.055	0.000	0.076	0.000	0.006	0.321	0.196	0.026	1.076

Table 4-11
Maricopa County (AZ) Base Case Activity Data (per Average Day)

Year, Season	Parameter	Light-Duty Gasoline	Heavy-Duty Gasoline	Motorcycle	Light-Duty Diesel	Heavy-Duty Diesel	Hoteling (Idling/APU)	Total On-Road
2011, Summer	Vehicles	5,212,078	64,417	150,618	18,169	55,633	0	5,500,915
	VMT	71,755,828	1,479,330	1,583,943	468,058	7,192,041	0	82,479,200
	Trips	13,824,600	168,742	57,050	97,576	263,454	0	14,411,422
	Hours	4,156,808	81,834	93,203	13,374	183,214	11,792	4,540,227
2011, Winter	Vehicles	5,212,078	64,417	150,618	18,169	55,633	0	5,500,915
	VMT	75,734,202	1,561,349	1,671,761	494,008	7,590,794	0	87,052,114
	Trips	13,824,600	168,742	57,050	97,576	263,454	0	14,411,422
	Hours	4,390,102	86,464	98,427	14,126	193,634	12,446	4,795,200
2022, Summer	Vehicles	6,339,816	79,452	184,014	33,606	82,130	0	6,719,018
	VMT	88,502,079	2,043,804	1,959,981	976,325	10,145,380	0	103,627,569
	Trips	16,819,852	207,280	69,699	179,717	383,095	0	17,659,642
	Hours	5,122,703	115,282	115,331	28,148	258,445	17,556	5,657,464
2022, Winter	Vehicles	6,339,816	79,452	184,014	33,606	82,130	0	6,719,018
	VMT	93,408,964	2,157,122	2,068,648	1,030,456	10,707,876	0	109,373,065
	Trips	16,819,852	207,280	69,699	179,717	383,095	0	17,659,642
	Hours	5,410,209	121,808	121,795	29,729	273,144	18,530	5,975,214
2050, Summer	Vehicles	10,290,841	130,055	299,121	61,659	145,257	0	10,926,934
	VMT	143,720,678	3,381,654	3,186,017	1,721,635	18,187,917	0	170,197,900
	Trips	27,302,361	339,049	113,298	329,118	672,927	0	28,756,753
	Hours	8,318,736	190,493	187,474	49,704	462,705	33,555	9,242,667
2050, Winter	Vehicles	10,290,841	130,055	299,121	61,659	145,257	0	10,926,934
	VMT	151,688,985	3,569,144	3,362,663	1,817,089	19,196,333	0	179,634,215
	Trips	27,302,361	339,049	113,298	329,118	672,927	0	28,756,753
	Hours	8,785,618	201,278	197,982	52,495	489,024	35,416	9,761,813

Figure 4-17
Maricopa County (AZ) VMT
Base Case (Miles per Average Summer Day)

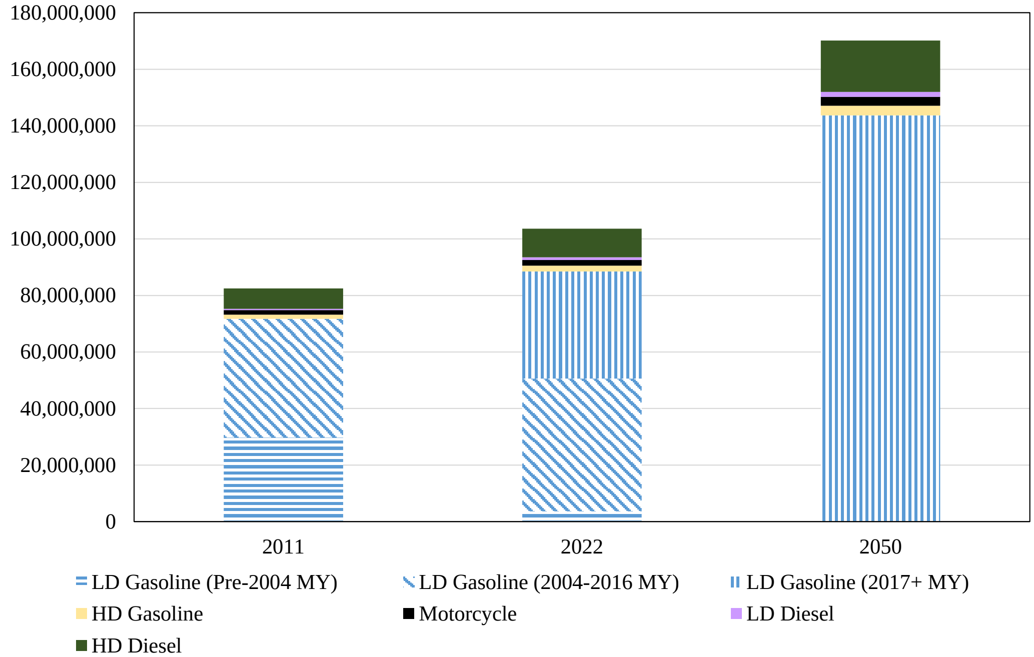


Figure 4-18
Maricopa County (AZ) Vehicle Population
Base Case (Summer Average Day)

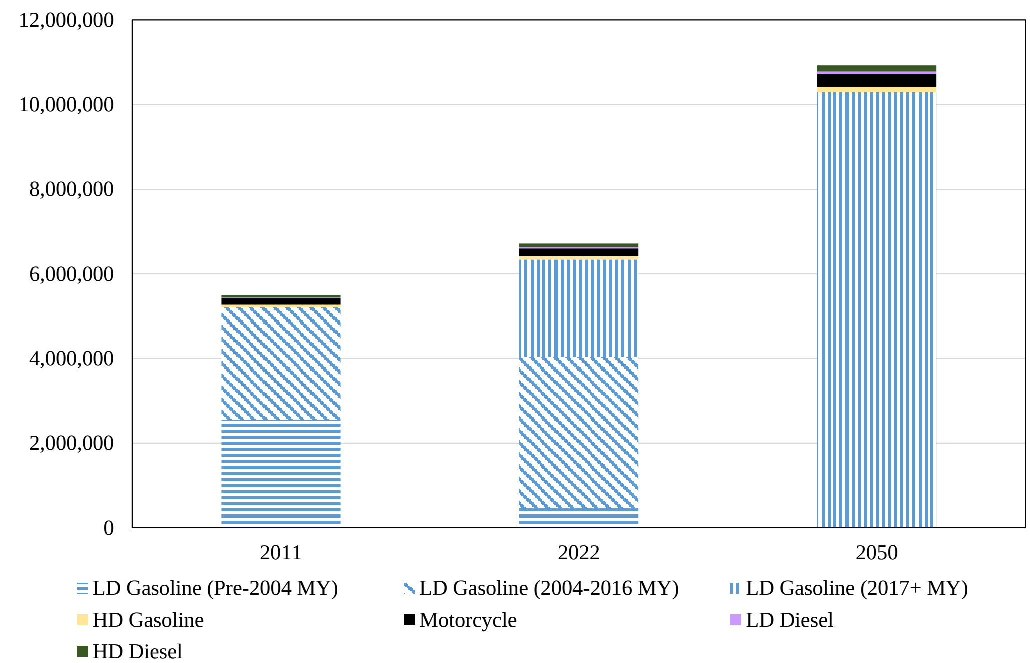


Figure 4-19
Maricopa County (AZ) Total Hydrocarbons (Exhaust & Evaporative)
Base Case (Tons per Summer Average Day)

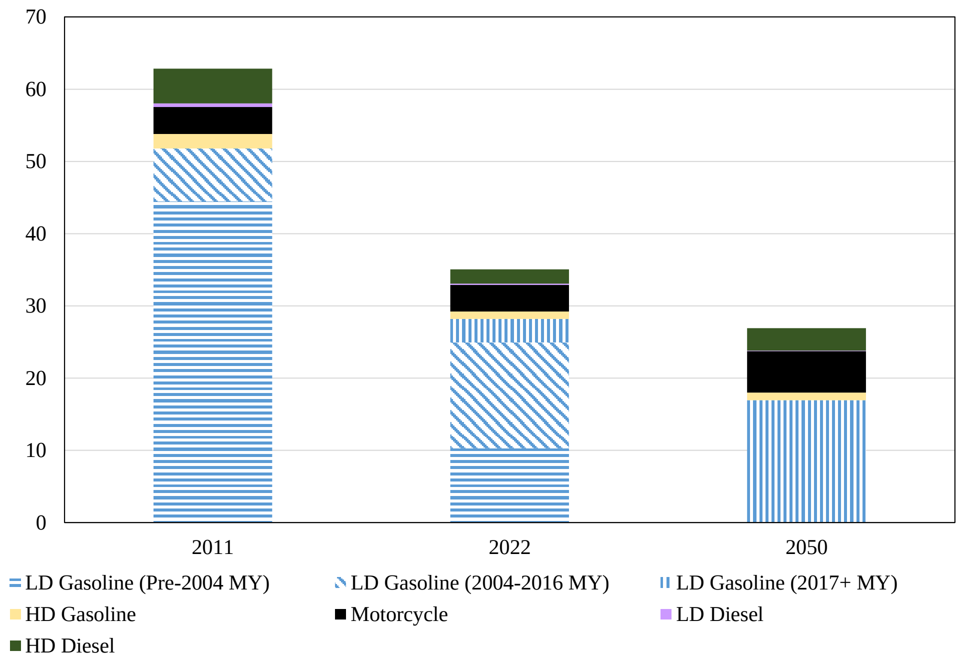


Figure 4-20
Maricopa County (AZ) Total Hydrocarbons (Exhaust)
Base Case (Tones per Summer Average Day)

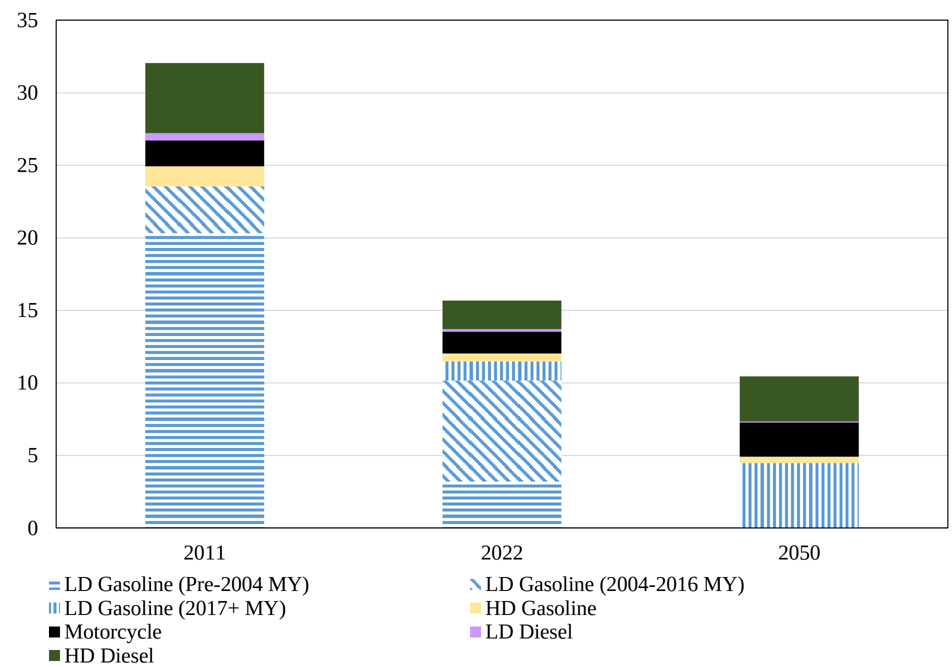


Figure 4-21
Maricopa County (AZ) Total Hydrocarbons (Evaporative)
Base Case (Tons per Summer Average Day)

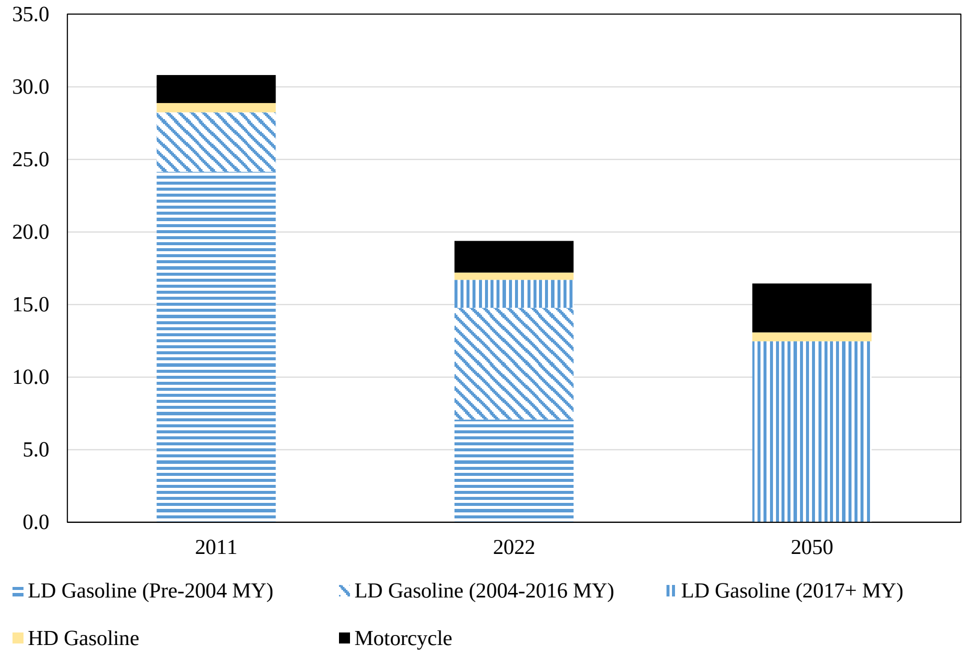


Figure 4-22
Maricopa County (AZ) Oxides of Nitrogen
Base Case (Tons per Summer Average Day)

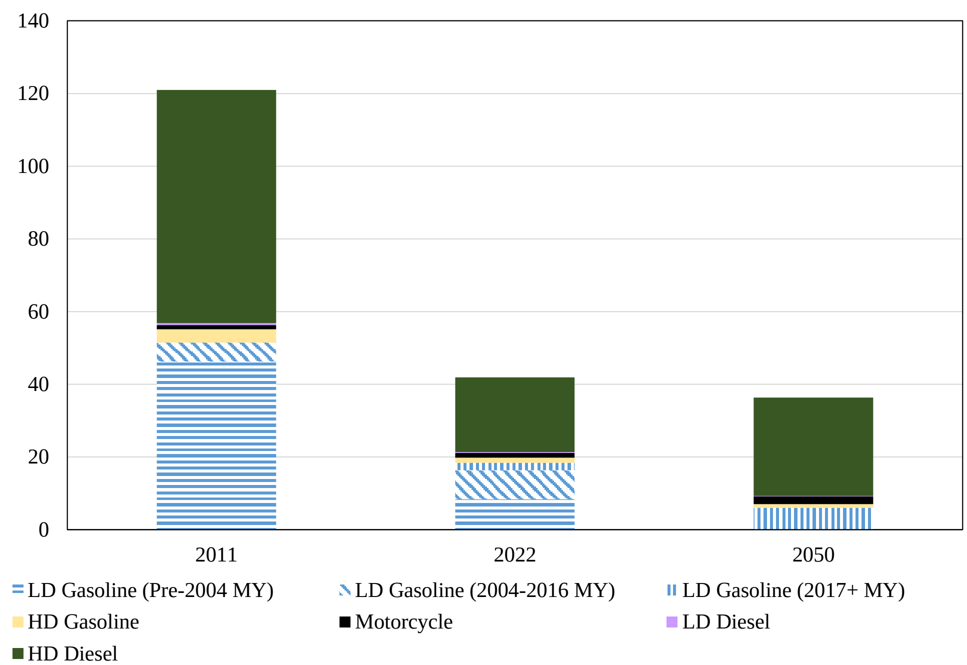


Figure 4-23
Maricopa County (AZ) $PM_{2.5}$
Base Case (Tons per Summer Average Day)

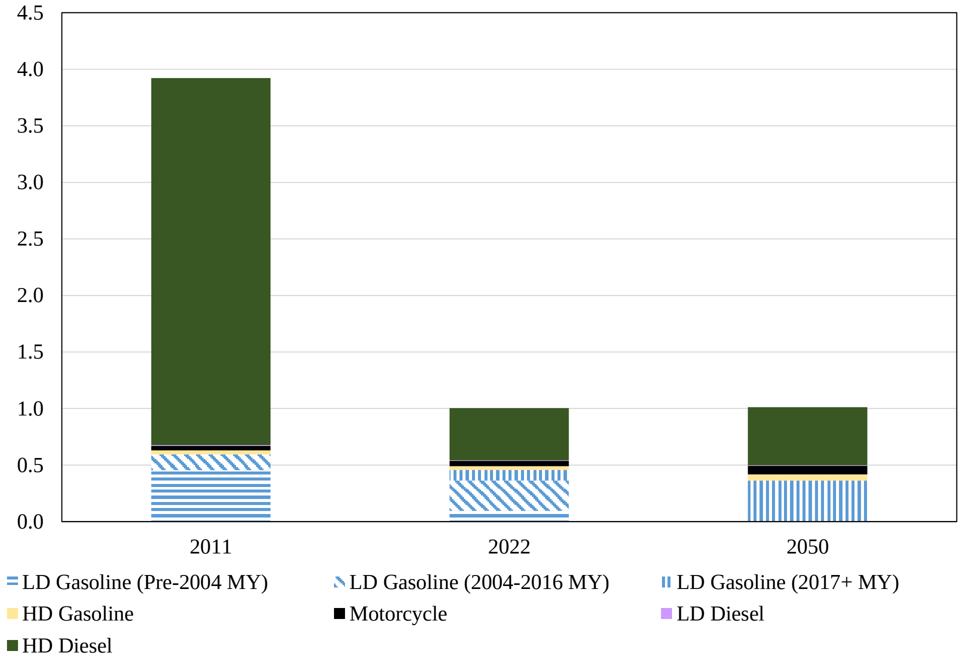


Figure 4-24
Maricopa County (AZ) Carbon Monoxide
Base Case (Tons per Summer Average Day)

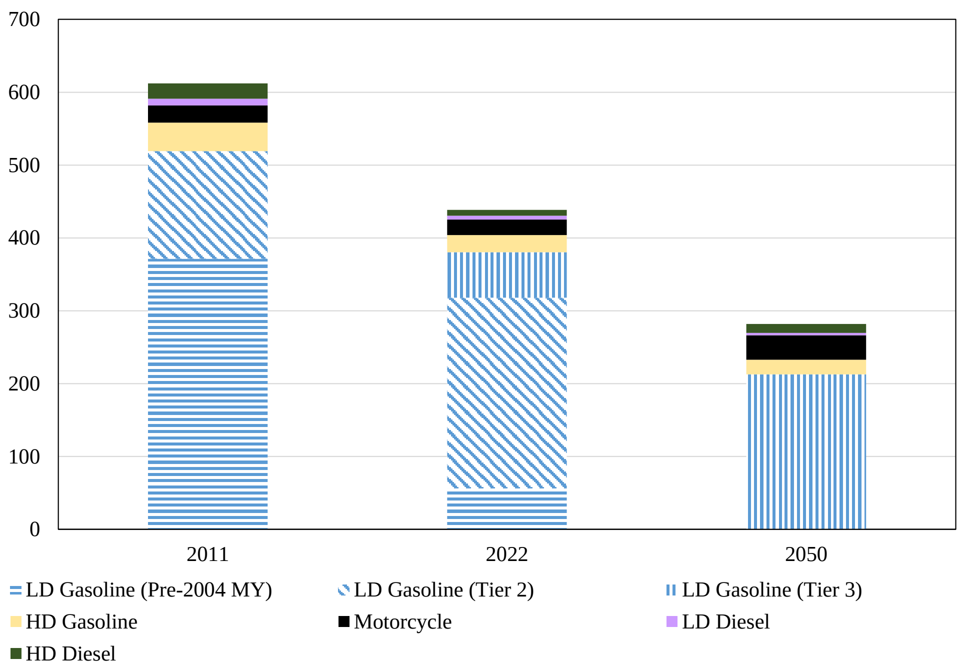


Figure 4-25
Maricopa County (AZ) VMT
Base Case (Miles per Winter Average Day)

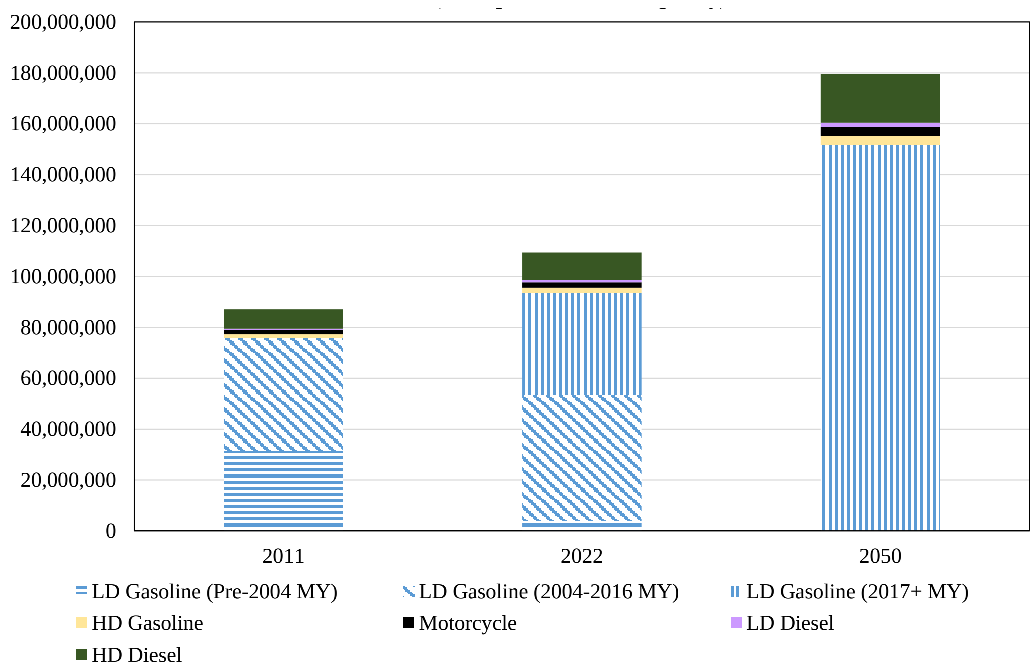


Figure 4-26
Maricopa County (AZ) Vehicle Population
Base Case (Winter Average Day)

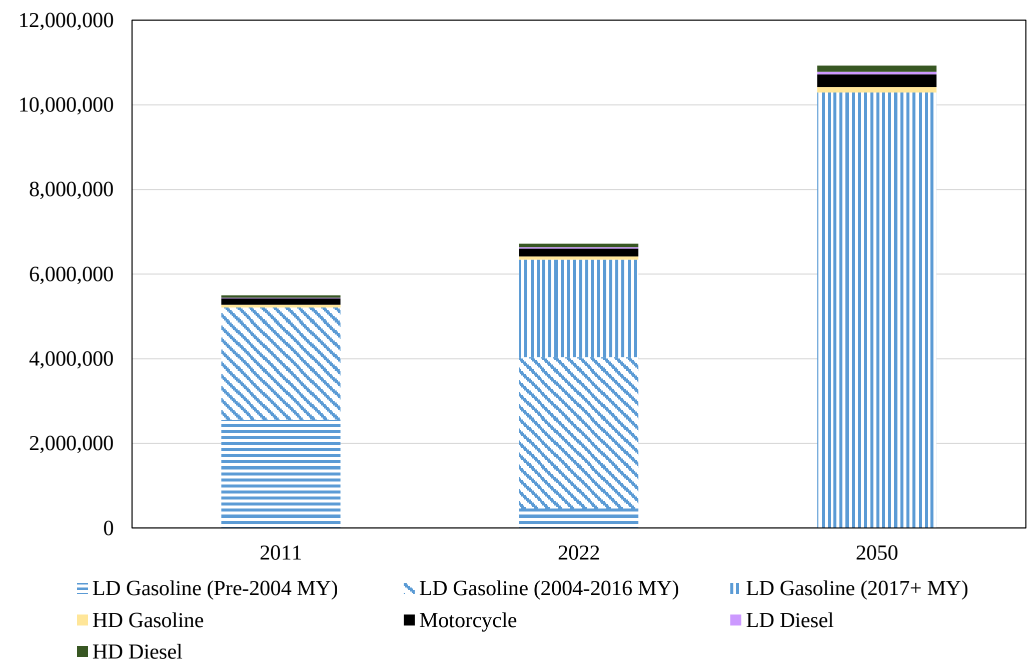


Figure 4-27
Maricopa County (AZ) Total Hydrocarbons (Exhaust & Evaporative)
Base Case (Tons per Winter Average Day)

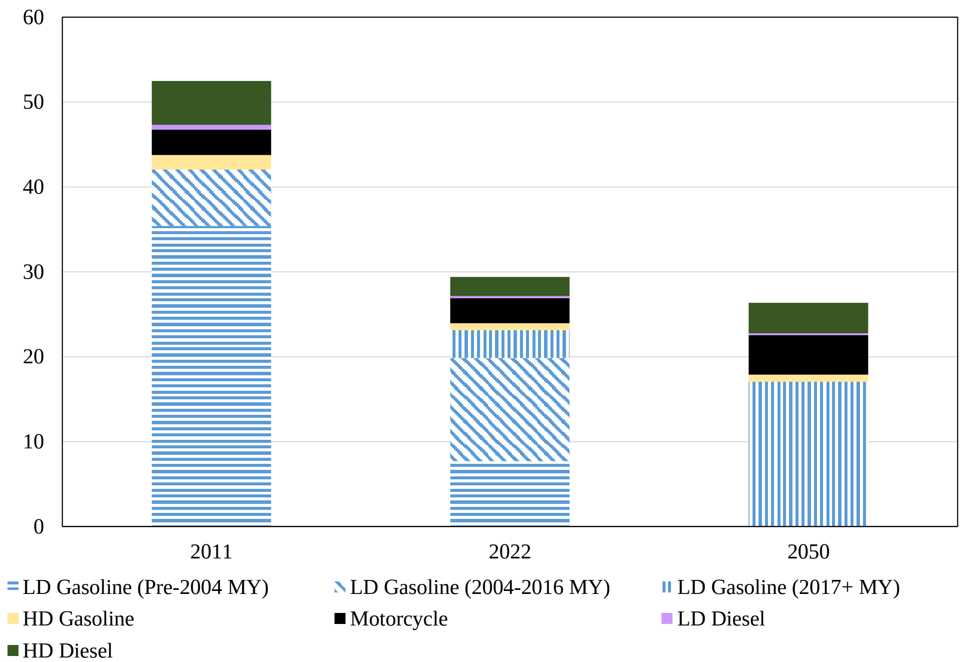


Figure 4-28
Maricopa County (AZ) Total Hydrocarbons (Exhaust)
Base Case (Tons per Winter Average Day)

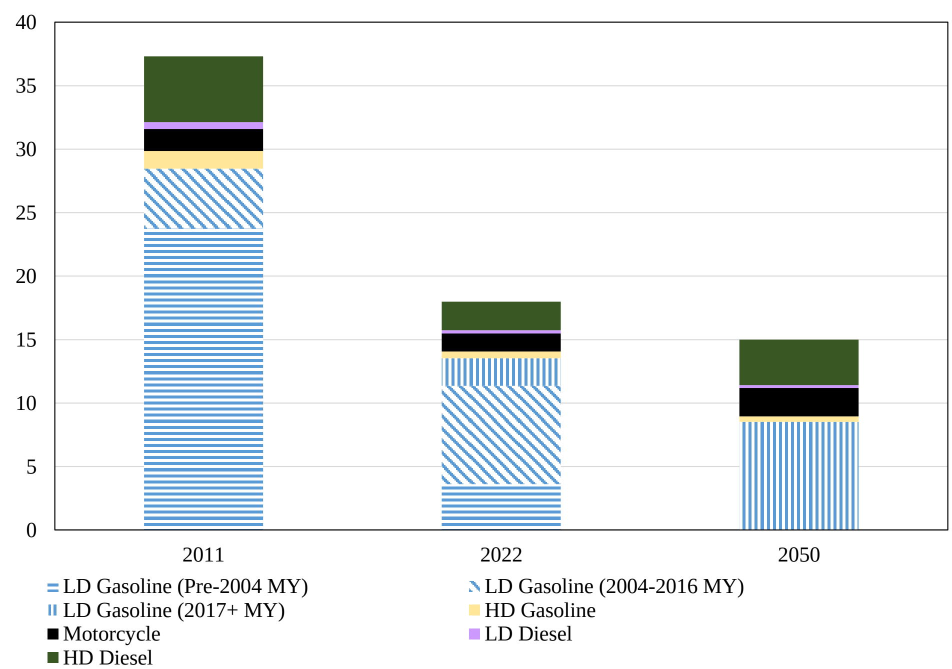


Figure 4-29
Maricopa County (AZ) Total Hydrocarbons (Evaporative)
Base Case (Tons per Winter Average Day)

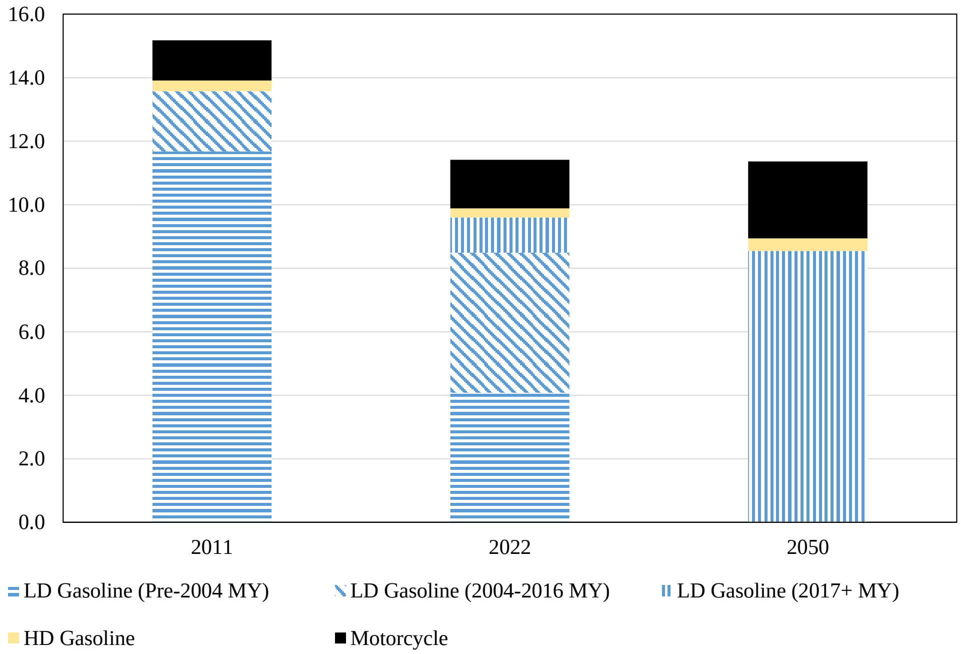


Figure 4-30
Maricopa County (AZ) Oxides of Nitrogen
Base Case (Tons per Winter Average Day)

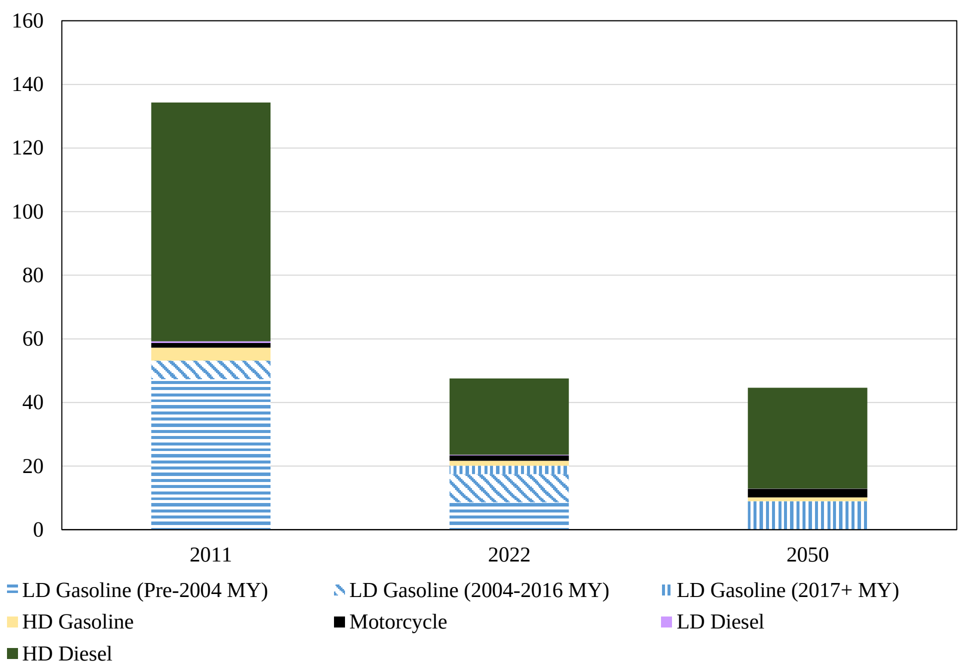


Figure 4-31
Maricopa County (AZ) $PM_{2.5}$
Base Case (Tones per Winter Average Day)

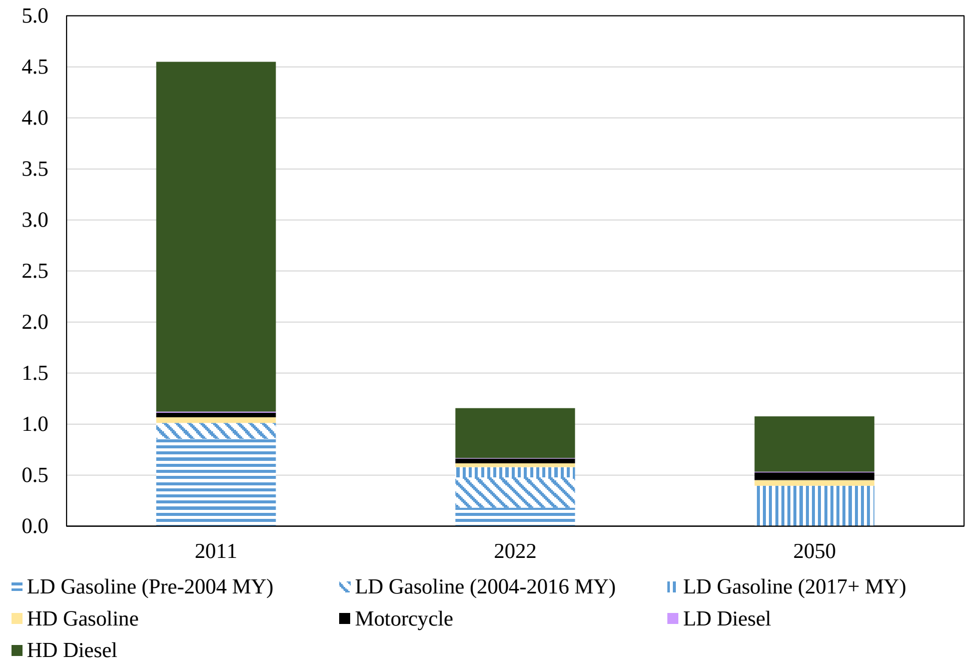
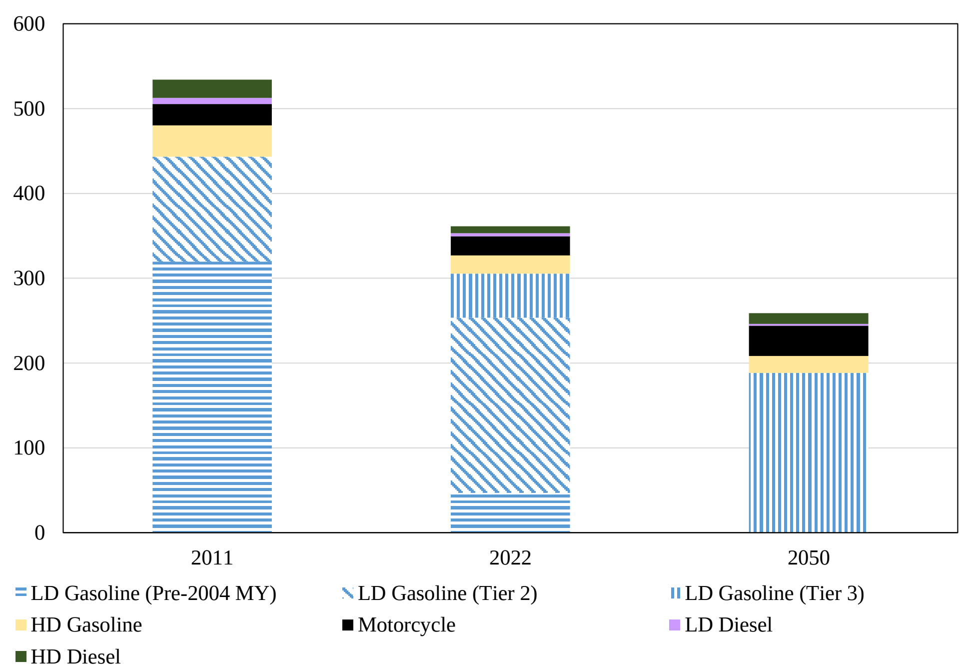


Figure 4-32
Maricopa County (AZ) Carbon Monoxide
Base Case (Tones per Winter Average Day)



For Wayne County, Base Case inventory results are presented in Table 4-12, and the activity data are presented in Table 4-13. Time series plots by season are then presented in a series of figures, as listed below.

- Figure 4-33. Wayne County (MI) Summer, VMT
- Figure 4-34. Wayne County (MI) Summer, Vehicles
- Figure 4-35. Wayne County (MI) Summer, THC (Exhaust & Evaporative)
- Figure 4-36. Wayne County (MI) Summer, THC (Exhaust)
- Figure 4-37. Wayne County (MI) Summer, THC (Evaporative)
- Figure 4-38. Wayne County (MI) Summer, NOx
- Figure 4-39. Wayne County (MI) Summer, $PM_{2.5}$
- Figure 4-40. Wayne County (MI) Summer, CO
- Figure 4-41. Wayne County (MI) Winter, VMT
- Figure 4-42. Wayne County (MI) Winter, Vehicles
- Figure 4-43. Wayne County (MI) Winter, THC (Exhaust & Evaporative)
- Figure 4-44. Wayne County (MI) Winter, THC (Exhaust)
- Figure 4-45. Wayne County (MI) Winter, THC (Evaporative)
- Figure 4-46. Wayne County (MI) Winter, NOx
- Figure 4-47. Wayne County (MI) Winter, $PM_{2.5}$
- Figure 4-48. Wayne County (MI) Winter, CO

Table 4-12 Wayne County (MI) Base Case Inventory Results (Tons per Average Day)												
Year, Season	**Pollutant**	**Light-Duty Gasoline**		**Heavy-Duty Gasoline**		**Motorcycle**		**Light-Duty Diesel**	**Heavy-Duty Diesel**			**Total On-Road**
		Exhaust	**Evap.**	**Exhaust**	**Evap.**	**Exhaust**	**Evap.**		**Exhaust**	**Crank-case**	**Idle / APU**	
2011, Summer	THC	17.624	9.895	1.194	0.491	0.697	0.679	0.208	2.980	0.125	0.781	34.673
	CO	309.387	0.000	29.230	0.000	10.115	0.000	3.681	13.699	0.208	1.253	367.574
	NOx	35.275	0.000	3.518	0.000	0.414	0.000	0.256	38.064	0.034	2.893	80.454
	$PM_{2.5}$	0.331	0.000	0.028	0.000	0.016	0.000	0.004	1.674	0.435	0.056	2.544
2011, Winter	THC	31.232	4.251	1.152	0.231	0.600	0.364	0.243	2.652	0.110	0.660	41.497
	CO	361.667	0.000	28.319	0.000	9.716	0.000	2.639	11.457	0.172	1.065	415.036
	NOx	36.153	0.000	3.713	0.000	0.464	0.000	0.232	38.717	0.035	2.957	82.272
	$PM_{2.5}$	1.314	0.000	0.100	0.000	0.026	0.000	0.003	1.419	0.369	0.047	3.278
2022, Summer	THC	5.107	4.592	0.300	0.298	0.440	0.639	0.046	0.793	0.014	0.649	12.877
	CO	162.072	0.000	11.512	0.000	6.960	0.000	1.438	3.509	0.019	1.211	186.722
	NOx	7.415	0.000	0.775	0.000	0.371	0.000	0.064	9.106	0.003	2.354	20.089
	$PM_{2.5}$	0.231	0.000	0.019	0.000	0.015	0.000	0.002	0.223	0.086	0.014	0.591
2022, Winter	THC	10.861	2.171	0.308	0.148	0.358	0.355	0.116	0.820	0.013	0.550	15.698
	CO	162.807	0.000	10.177	0.000	6.295	0.000	0.941	2.994	0.016	1.026	184.255
	NOx	8.707	0.000	0.830	0.000	0.412	0.000	0.058	9.245	0.003	2.407	21.663
	$PM_{2.5}$	0.466	0.000	0.031	0.000	0.014	0.000	0.002	0.189	0.073	0.012	0.787
2050, Summer	THC	1.217	2.487	0.127	0.247	0.412	0.593	0.014	0.538	0.001	0.729	6.365
	CO	56.168	0.000	4.621	0.000	6.637	0.000	0.606	2.499	0.001	1.386	71.917
	NOx	1.651	0.000	0.280	0.000	0.372	0.000	0.016	5.250	0.000	2.624	10.193
	$PM_{2.5}$	0.129	0.000	0.018	0.000	0.016	0.000	0.001	0.075	0.046	0.013	0.297
2050, Winter	THC	6.476	1.457	0.153	0.131	0.317	0.349	0.100	0.618	0.001	0.617	10.220
	CO	77.326	0.000	4.462	0.000	5.790	0.000	0.396	2.159	0.000	1.174	91.308
	NOx	3.319	0.000	0.312	0.000	0.412	0.000	0.015	5.338	0.000	2.683	12.079
	$PM_{2.5}$	0.187	0.000	0.017	0.000	0.012	0.000	0.001	0.063	0.039	0.011	0.330

Table 4-13 Wayne County (MI) Base Case Activity Data (per Average Day)								
Year, Season	**Parameter**	**Light-Duty Gasoline**	**Heavy-Duty Gasoline**	**Motorcycle**	**Light-Duty Diesel**	**Heavy-Duty Diesel**	**Hoteling (Idling/APU)**	**Total On-Road**
2011, Summer	Vehicles	2,266,090	35,525	60,564	8,028	25,614	0	2,395,821
	VMT	41,887,004	1,026,770	551,065	283,822	3,891,993	0	47,640,654
	Trips	6,009,470	86,345	22,940	42,826	116,442	0	6,278,024
	Hours	2,454,761	60,710	30,398	8,322	98,620	13,299	2,666,110
2011, Winter	Vehicles	2,266,090	35,525	60,564	8,028	25,614	0	2,395,821
	VMT	35,479,658	869,708	466,770	240,406	3,296,645	0	40,353,187
	Trips	6,009,470	86,345	22,940	42,826	116,442	0	6,278,024
	Hours	2,079,410	51,427	25,751	7,050	83,541	11,265	2,258,444
2022, Summer	Vehicles	2,288,097	33,429	61,325	10,543	28,023	0	2,421,416
	VMT	40,833,929	1,030,833	538,624	386,230	4,460,518	0	47,250,133
	Trips	6,067,959	82,567	23,228	56,123	127,013	0	6,356,889
	Hours	2,391,283	62,360	29,712	11,322	113,303	14,730	2,622,709
2022, Winter	Vehicles	2,288,097	33,429	61,325	10,543	28,023	0	2,421,416
	VMT	34,587,664	873,149	456,232	327,149	3,778,206	0	40,022,400
	Trips	6,067,959	82,567	23,228	56,123	127,013	0	6,356,889
	Hours	2,025,638	52,825	25,170	9,591	95,979	12,477	2,221,678
2050, Summer	Vehicles	2,445,942	35,111	65,636	12,643	30,459	0	2,589,791
	VMT	41,433,115	1,060,319	547,010	422,442	4,970,178	0	48,433,063
	Trips	6,486,607	87,532	24,861	67,224	137,485	0	6,803,709
	Hours	2,426,572	63,852	30,174	12,383	125,756	17,269	2,676,006
2050, Winter	Vehicles	2,445,942	35,111	65,636	12,643	30,459	0	2,589,791
	VMT	35,095,173	898,125	463,335	357,822	4,209,900	0	41,024,354
	Trips	6,486,607	87,532	24,861	67,224	137,485	0	6,803,709
	Hours	2,055,531	54,089	25,562	10,489	106,528	14,628	2,266,826

Figure 4-33
Wayne County (MI) VMT
Base Case (Miles per Average Summer Day)

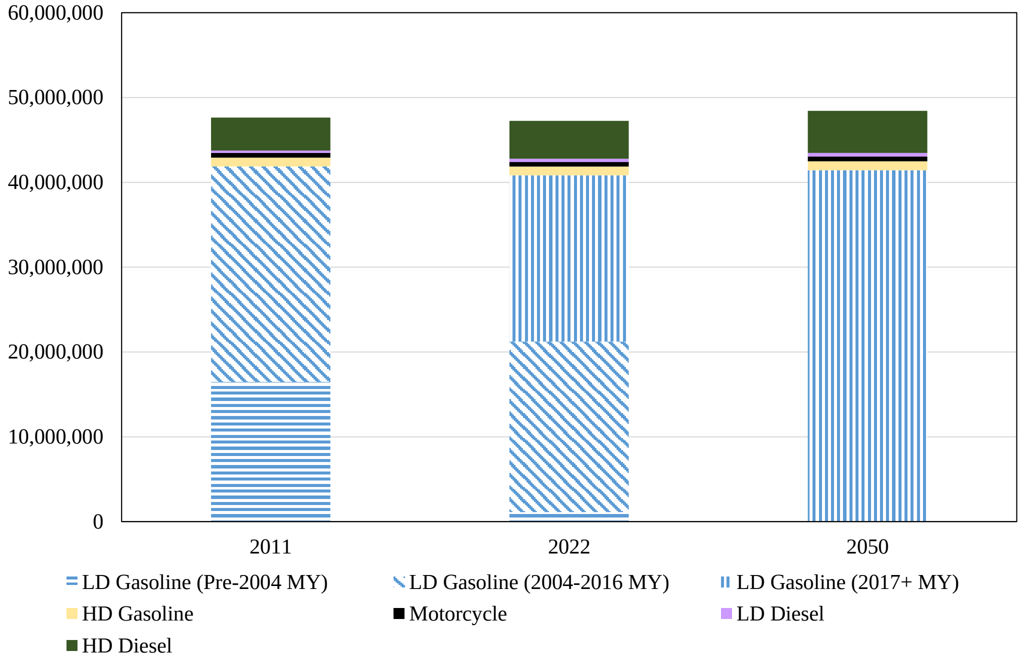


Figure 4-34
Wayne County (MI) Vehicle Population
Base Case (Summer Average Day)

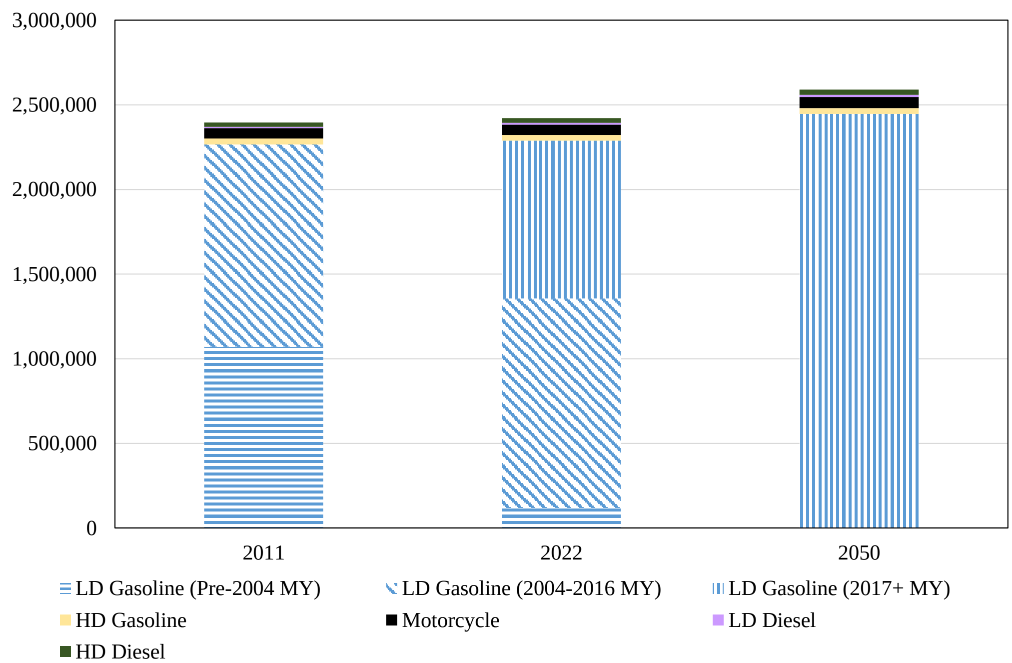


Figure 4-35
Wayne County (MI) Total Hydrocarbons (Exhaust & Evaporative)
Base Case (Tons per Summer Average Day)

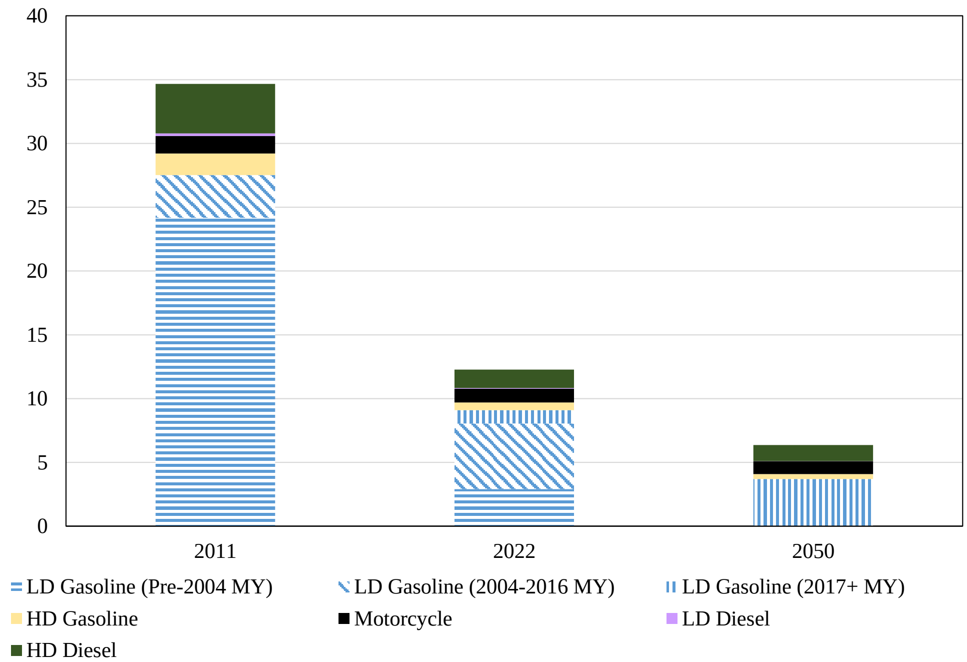


Figure 4-36
Wayne County (MI) Total Hydrocarbons (Exhaust)
Base Case (Tons per Summer Average Day)

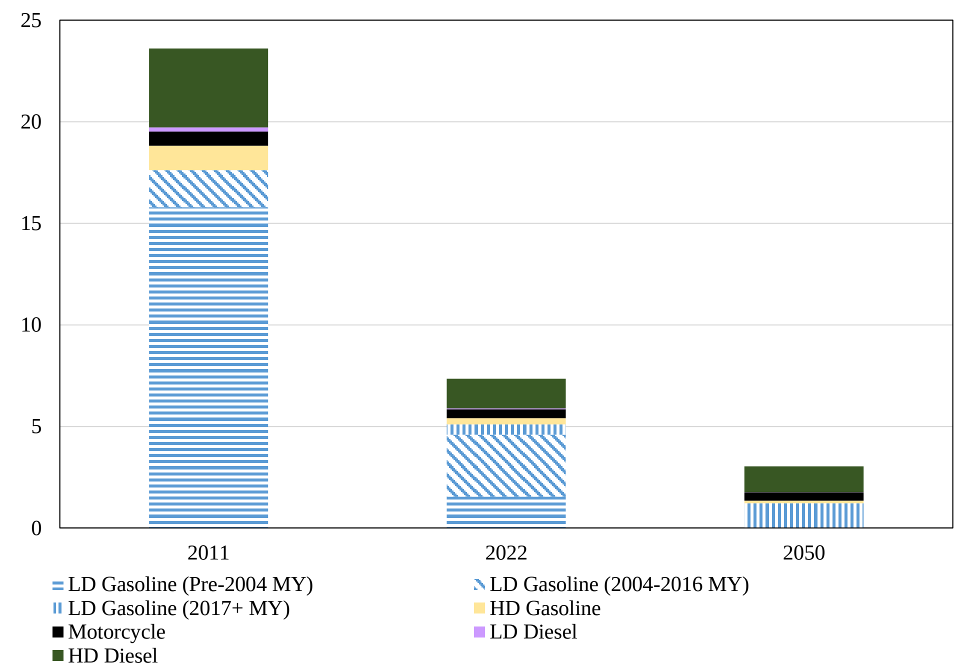


Figure 4-37
Wayne County (MI) Total Hydrocarbons (Evaporative)
Base Case (Tones per Summer Average Day)

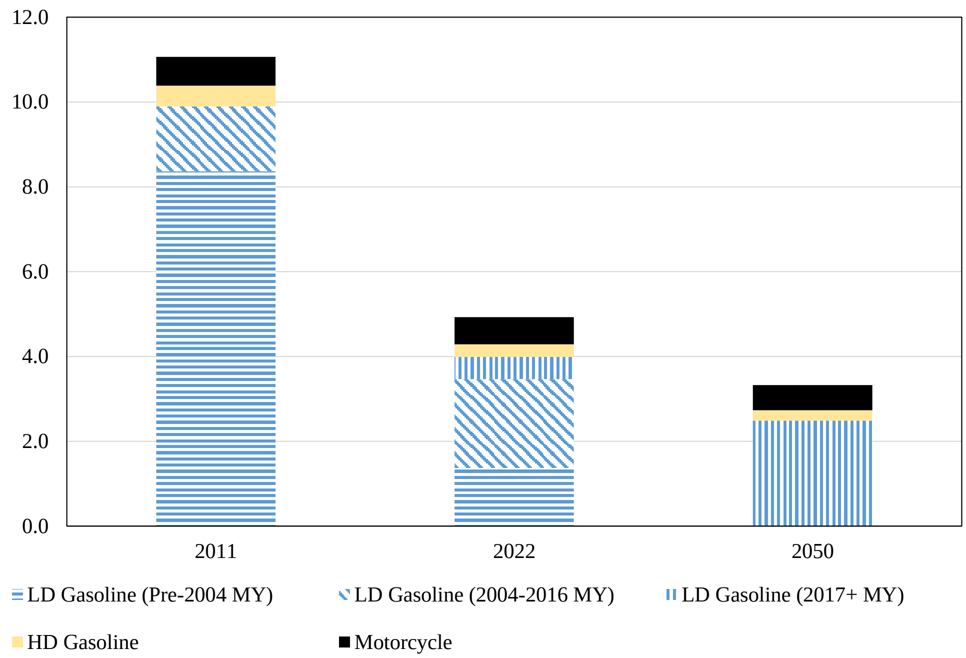


Figure 4-38
Wayne County (MI) Oxides of Nitrogen
Base Case (Tons per Summer Average Day)

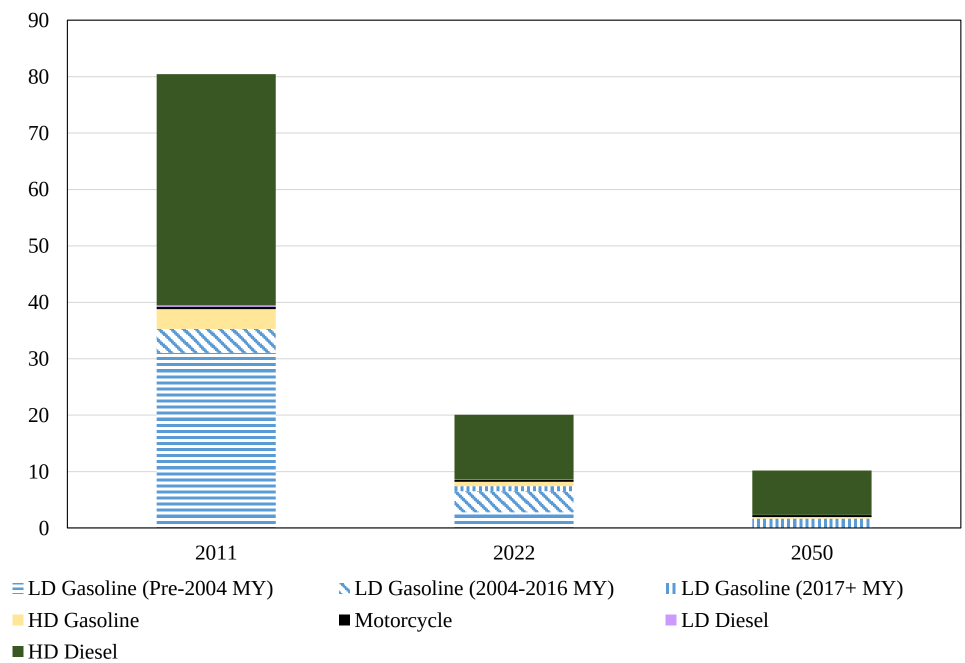


Figure 4-39
Wayne County (MI) $PM_{2.5}$
Base Case (Tons per Summer Average Day)

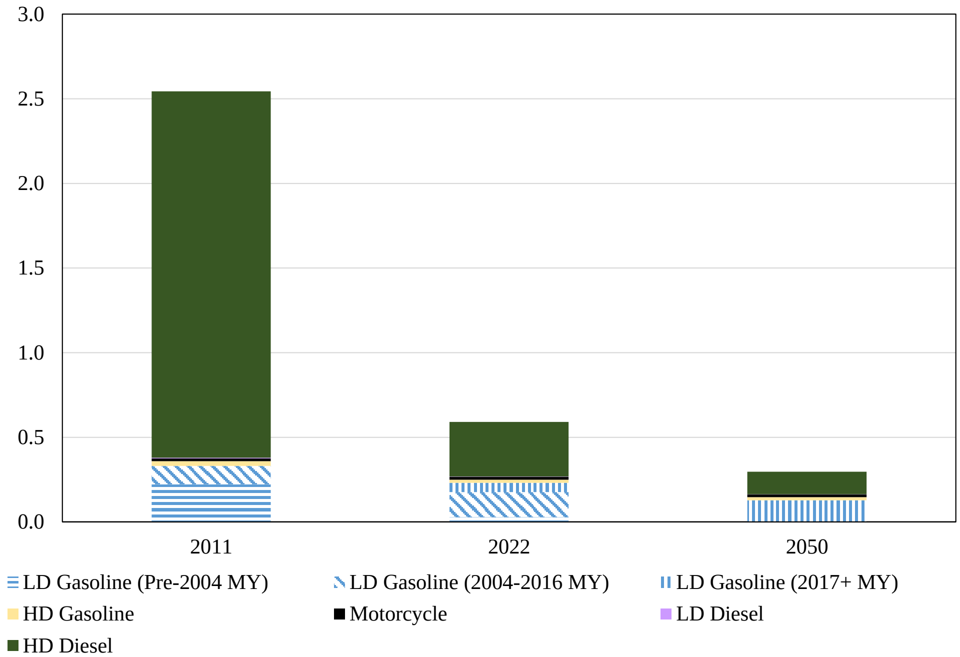


Figure 4-40
Wayne County (MI) Carbon Monoxide
Base Case (Tons per Summer Average Day)

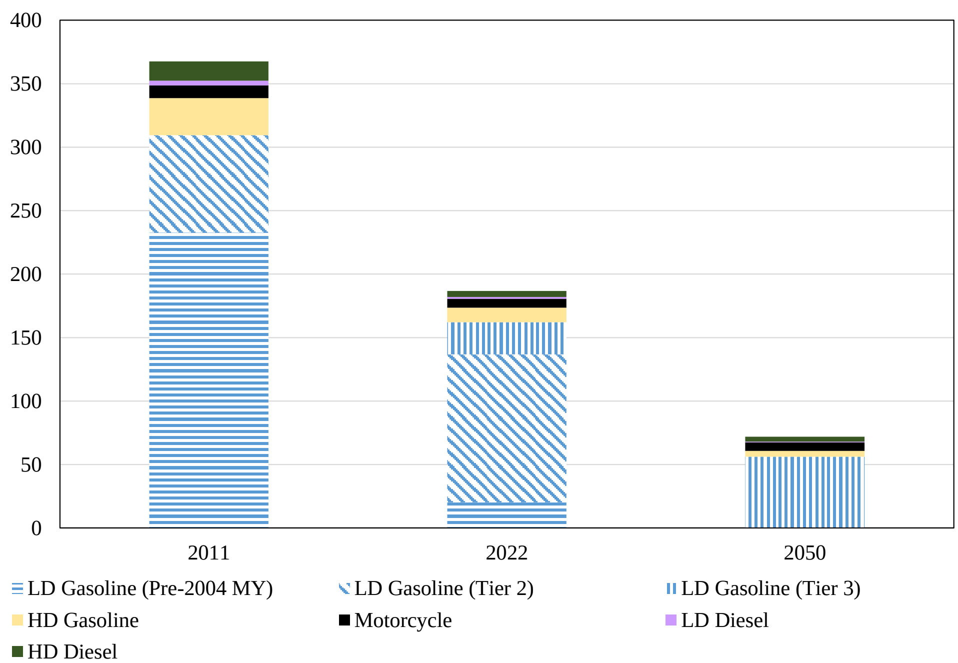


Figure 4-41
Wayne County (MI) VMT
Base Case (Miles per Winter Average Day)

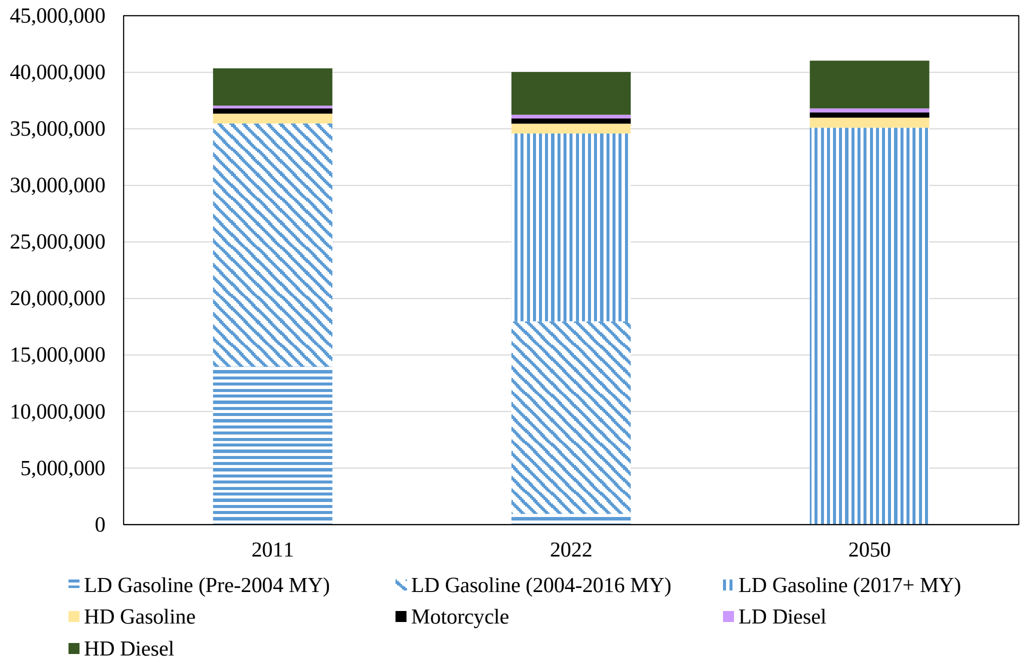


Figure 4-42
Wayne County (MI) Vehicle Population
Base Case (Winter Average Day)

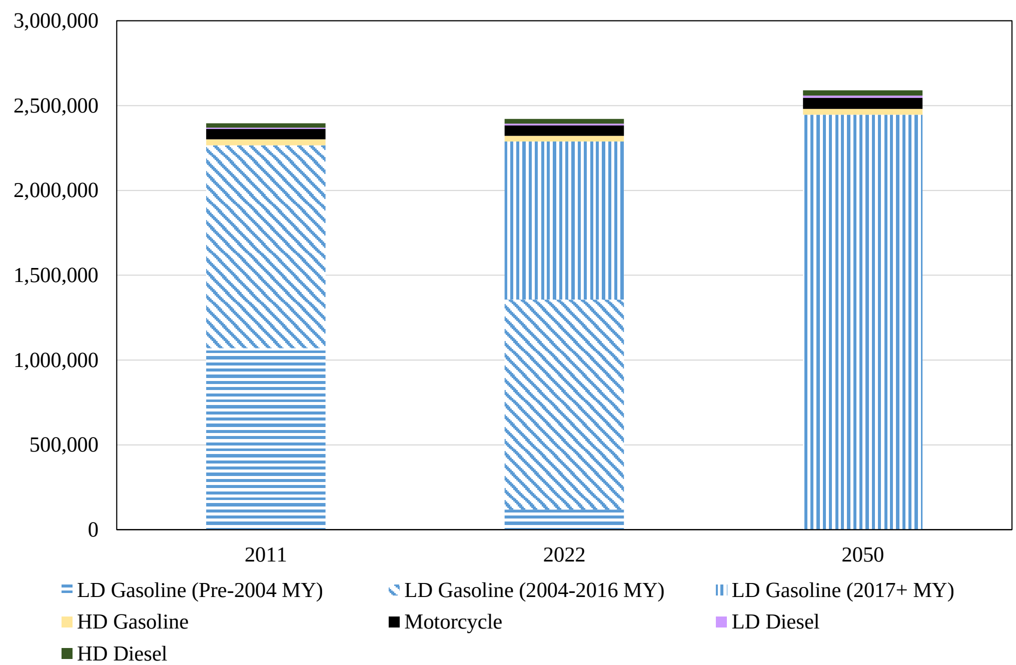


Figure 4-43
Wayne County (MI) Total Hydrocarbons (Exhaust & Evaporative)
Base Case (Tons per Winter Average)

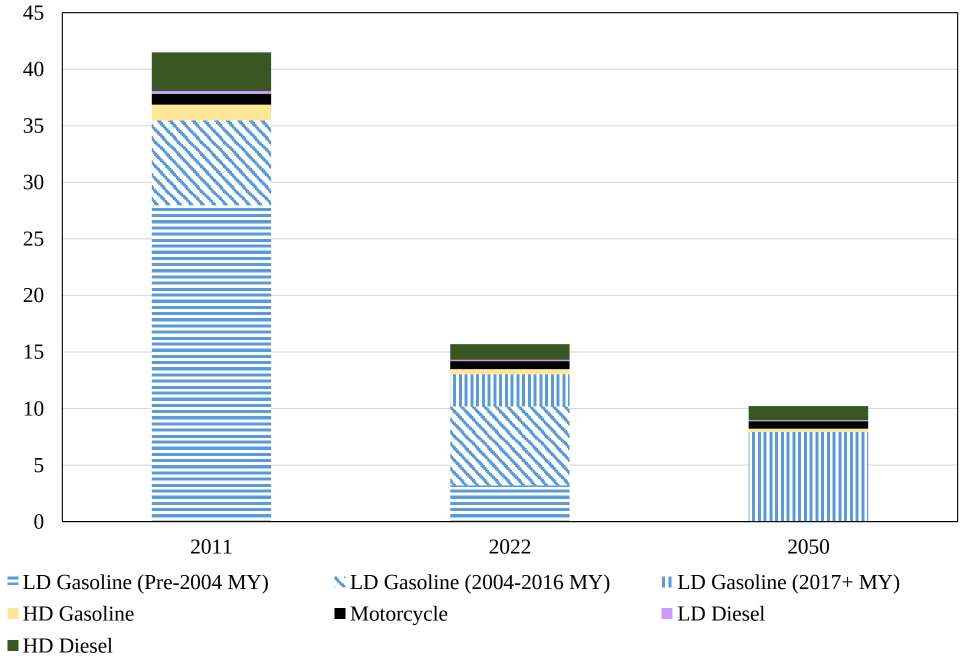


Figure 4-44
Wayne County (MI) Total Hydrocarbons (Exhaust)
Base Case (Tons per Winter Average Day)

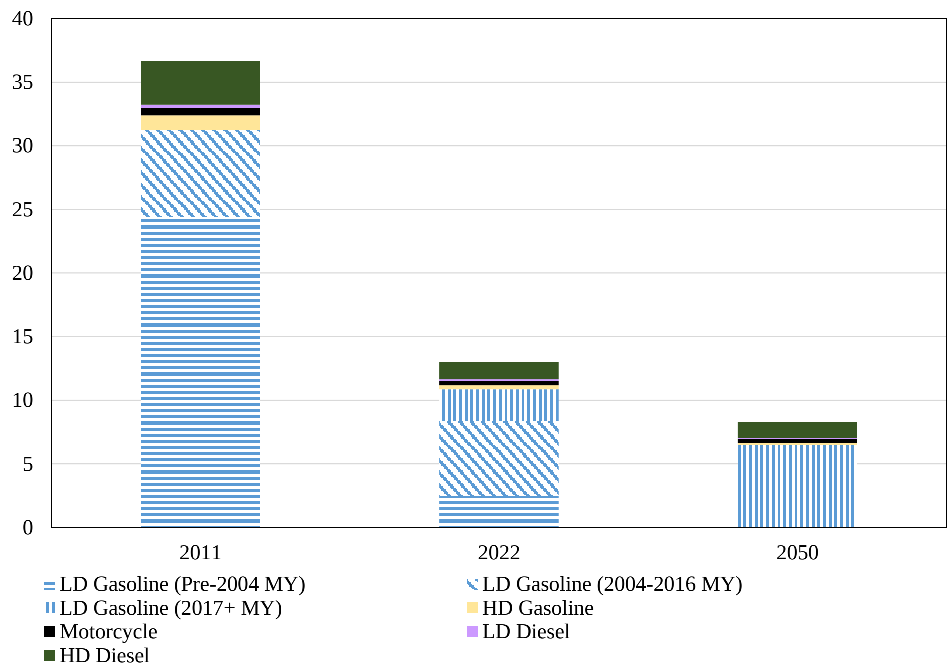


Figure 4-45
Wayne County (MI) Total Hydrocarbons (Evaporative)
Base Case (Tons per Winter Average Day)

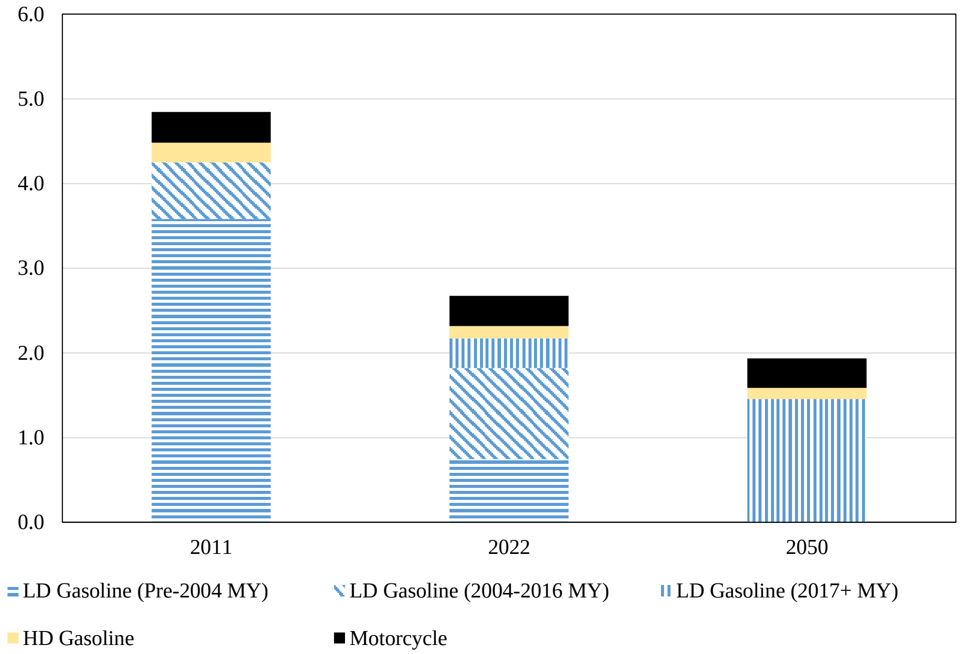


Figure 4-46
Wayne County (MI) Oxides of Nitrogen
Base Case (Tones per Winter Average Day)

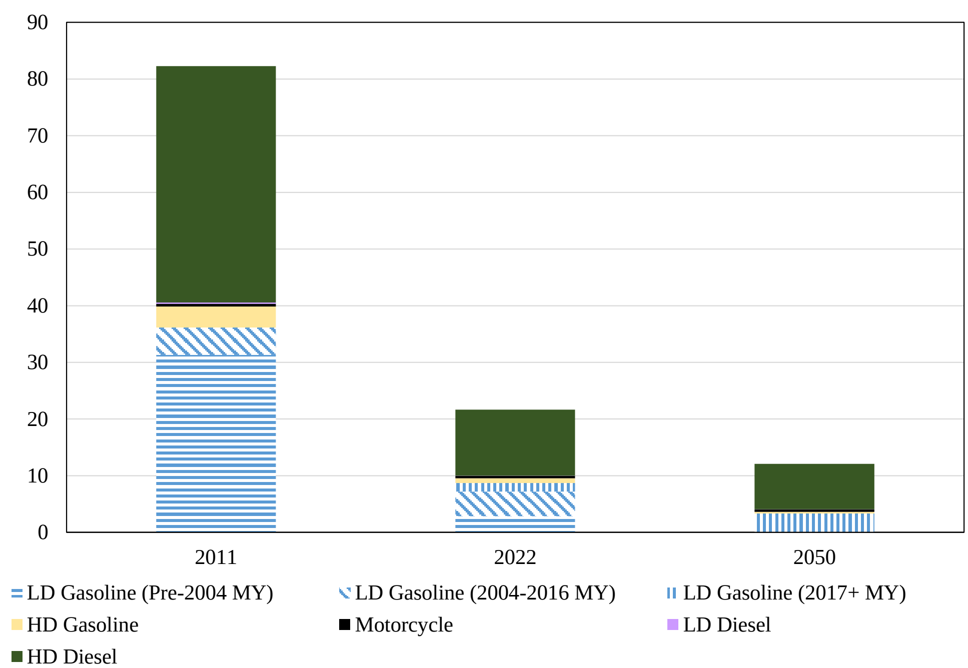


Figure 4-47
Wayne County (MI) $PM_{2.5}$
Base Case (Tons per Winter Average Day)

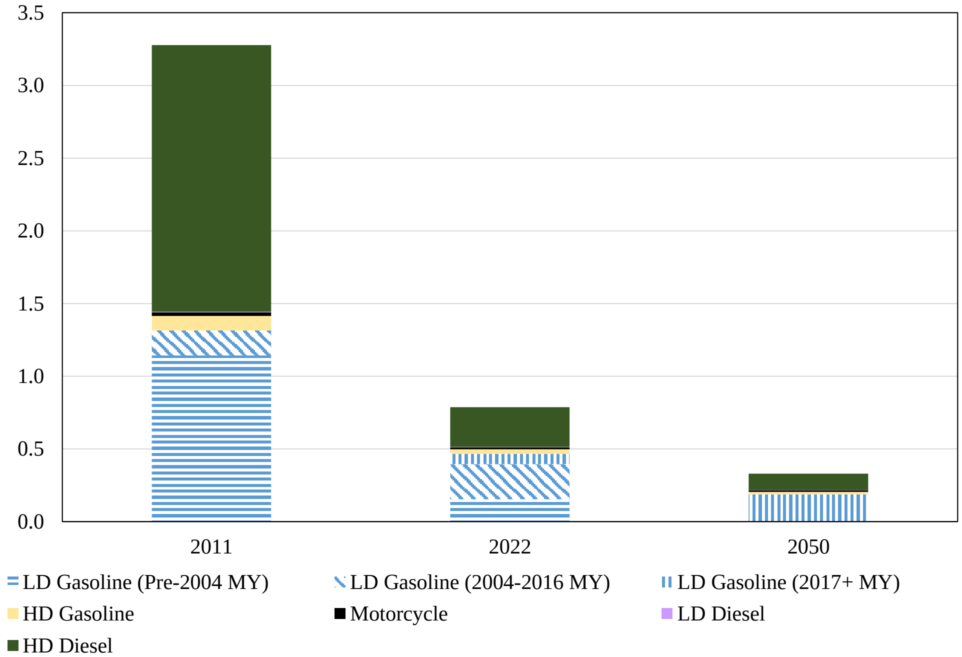
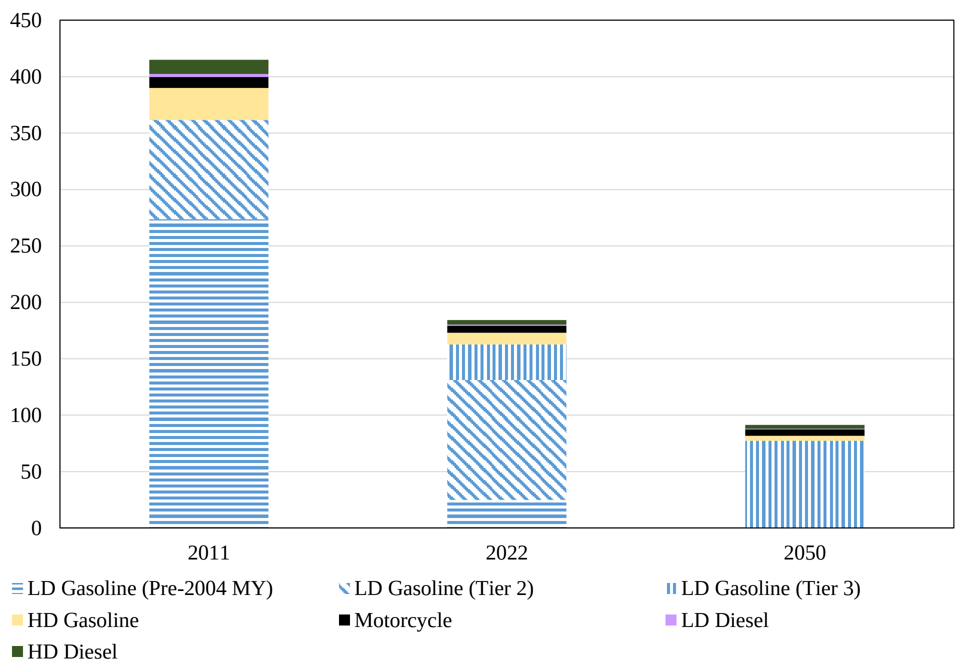


Figure 4-48
Wayne County (MI) Carbon Monoxide
Base Case (Tons per Winter Average Day)



The most remarkable observation from the collective set of Base Case results across all three locations is the significant decline in emissions over the three years of study for all pollutants and seasons. In spite of the enormous variety of conditions represented by these three locations (see Table 4-1), the inventory trend is dominated by a national trend. As noted below, the reductions in emissions are substantial.

- By 2022, the average declines in THC, NOx, $PM_{2.5}$, and CO emissions from 2011 are 55%, 71%, 73% and 43%, respectively.

- By 2050, in all but one case (i.e., summer season $PM_{2.5}$ in Maricopa County) emissions remain below 2022 in spite of another 28 years of growth in on-road activity. The average decline in THC, NOx, $PM_{2.5}$, and CO emissions from 2011 is 69%, 81%, 82%, and 68%.

Another key observation is that the light-duty gasoline fleet is the predominate source of emissions in nearly all pollutants and seasons. For NOx and $PM_{2.5}$ emissions, the heavy-duty Diesel fleet also contributes substantially.

Within the dominating declining emissions trend noted above, there are some secondary differences that show up as variation in the results between the three locations.

- The level of on-road activity growth from 2011 varies considerably between the three locations, and this growth rate difference materializes in the time series inventory plots. Wayne County has lowest growth rate—an 8 and 2 percent increase in vehicles and VMT, respectively, by 2050. Maricopa County has the highest growth rate of a 99 and 106 percent increase in vehicles and VMT, respectively, by 2050. Fulton County falls in between with a growth rate of a 70 and 48 percent increase in vehicles and VMT, respectively, by 2050.

- The greater heavy-duty proportion of vehicles in Maricopa and Wayne Counties shows up in the inventory proportions for NOx and $PM_{2.5}$.

- Motorcycles have a greater contribution to the THC and CO inventories in Maricopa County.

Additional Base Case inventory and activity data results are provided in Appendix A, which contains more detailed inventory and activity data for the two primary vehicle classes of light-duty gasoline vehicles and for heavy-duty diesel vehicles. Base Case data are reported by model year group and by individual emissions process.

4.3 Sensitivity Scenario Results

The emission inventory results of each sensitivity scenario are reported for the three geographic locations of Fulton County, Maricopa County, and Wayne County for the three years of 2011, 2022, and 2050.   Inventories cover the criteria pollutants of THC, NOx,

$PM_{2.5}$, and CO. The activity levels are not impacted by the sensitivity scenarios and remain unchanged from the values reported for the Base Case results (see Section 4.2).

The sensitivity scenario results are expressed as a percent change in the total on-road inventory relative to the Base Case. In addition, the 100 percent E15 scenarios (Scenarios 4 and 5) are expressed as a percent change in the total on-road inventory relative to the 100 percent E10 case (Scenario 3). Note that the Maricopa County Base Case is 100 percent E10, such that Scenario 3 was not evaluated.[*]

For Fulton County, sensitivity scenario results are presented in Tables 4-14 and 4-15 for summer and winter seasons, respectively. Results by year and season are presented in a series of figures, as listed below.

- Figure 4-49. Fulton County (GA) Sensitivity Case Results, Summer 2011
- Figure 4-50. Fulton County (GA) Sensitivity Case Results, Summer 2022
- Figure 4-51. Fulton County (GA) Sensitivity Case Results, Summer 2050
- Figure 4-52. Fulton County (GA) Sensitivity Case Results, Winter 2011
- Figure 4-53. Fulton County (GA) Sensitivity Case Results, Winter 2022
- Figure 4-54. Fulton County (GA) Sensitivity Case Results, Winter 2050

[*] See Section 4.1.4 for a discussion of the specific inventory scenarios defined for each location.

Table 4-14 Fulton County (GA) Sensitivity Scenario Results, Summer Season						
			Percent Change in On-Road Inventory			
Year	**Scenario**	**Scenario Impact**	**THC**	**CO**	**NOx**	**$PM_{2.5}$**
2011	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	0.49%	0.58%	0.48%	-0.20%
	2	+1 PSI RVP Relative to Base Case	1.62%	0.96%	0.50%	0.00%
	3	100% E10 Relative to Base Case	0.47%	-0.87%	0.41%	0.08%
	4	100% E15 Relative to Base Case	1.70%	-5.69%	2.53%	0.31%
	4	100% E15 Relative to 100% E10	1.23%	-4.86%	2.10%	0.23%
	5	100% E15 (T50 Update) Relative to Base Case	1.26%	-6.04%	2.84%	0.31%
	5	100% E15 (T50 Update) Relative to 100% E10	0.79%	-5.21%	2.42%	0.23%
	6	Remove LD I/M Relative to Base Case	14.15%	14.61%	9.81%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	0.18%	0.00%
	8	Federal RFG Relative to Base Case	-6.36%	-4.16%	-1.06%	-1.28%
	9	National LDA/LDT Mix Relative to Base Case	-2.82%	-3.01%	-2.38%	-0.44%
2022	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	-0.53%	0.99%	0.11%	-0.97%
	2	+1 PSI RVP Relative to Base Case	0.36%	1.35%	0.17%	0.00%
	3	100% E10 Relative to Base Case	0.04%	0.48%	-0.19%	-0.13%
	4	100% E15 Relative to Base Case	-0.18%	-3.65%	1.49%	1.00%
	4	100% E15 Relative to 100% E10	-0.22%	-4.10%	1.69%	1.13%
	5	100% E15 (T50 Update) Relative to Base Case	-2.35%	-5.13%	1.06%	1.12%
	5	100% E15 (T50 Update) Relative to 100% E10	-2.38%	-5.58%	1.25%	1.25%
	6	Remove LD I/M Relative to Base Case	14.13%	16.95%	7.93%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	4.79%	0.00%
	8	Federal RFG Relative to Base Case	-3.26%	-2.82%	-0.66%	-6.44%
	9	National LDA/LDT Mix Relative to Base Case	-0.49%	-1.64%	-1.10%	-1.05%
2050	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	-0.50%	1.03%	-0.07%	-1.35%
	2	+1 PSI RVP Relative to Base Case	0.07%	1.34%	0.00%	0.00%
	3	100% E10 Relative to Base Case	0.13%	0.86%	-0.19%	-0.33%
	4	100% E15 Relative to Base Case	-0.39%	-3.02%	0.66%	1.16%
	4	100% E15 Relative to 100% E10	-0.52%	-3.85%	0.86%	1.50%
	5	100% E15 (T50 Update) Relative to Base Case	-2.32%	-4.64%	0.08%	1.34%
	5	100% E15 (T50 Update) Relative to 100% E10	-2.45%	-5.45%	0.27%	1.68%
	6	Remove LD I/M Relative to Base Case	19.64%	14.14%	4.30%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	20.37%	0.00%
	8	Federal RFG Relative to Base Case	-1.92%	-2.37%	-0.40%	-8.97%
	9	National LDA/LDT Mix Relative to Base Case	-0.54%	-0.84%	-0.27%	-1.27%

Table 4-15 Fulton County (GA) Sensitivity Scenario Results, Winter Season						
			Percent Change in On-Road Inventory			
Year	**Scenario**	**Scenario Impact**	**THC**	**CO**	**NOx**	**$PM_{2.5}$**
2011	3	100% E10 Relative to Base Case	-0.09%	-0.72%	0.37%	0.05%
	4	100% E15 Relative to Base Case	3.74%	-9.40%	2.48%	0.29%
	4	100% E15 Relative to 100% E10	3.84%	-8.73%	2.10%	0.24%
	5	100% E15 (T50 Update) Relative to Base Case	5.47%	-8.64%	2.72%	0.45%
	5	100% E15 (T50 Update) Relative to 100% E10	5.57%	-7.98%	2.34%	0.40%
	6	Remove LD I/M Relative to Base Case	11.19%	11.04%	8.99%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	0.17%	0.00%
	8	Federal RFG Relative to Base Case	-2.28%	-3.04%	0.29%	-0.31%
	9	National LDA/LDT Mix Relative to Base Case	-2.17%	-2.38%	-2.19%	-0.66%
2022	3	100% E10 Relative to Base Case	-0.13%	0.50%	-0.17%	-0.08%
	4	100% E15 Relative to Base Case	0.98%	-3.81%	1.30%	0.61%
	4	100% E15 Relative to 100% E10	1.11%	-4.28%	1.47%	0.69%
	5	100% E15 (T50 Update) Relative to Base Case	0.85%	-3.51%	1.01%	1.57%
	5	100% E15 (T50 Update) Relative to 100% E10	0.98%	-3.98%	1.19%	1.65%
	6	Remove LD I/M Relative to Base Case	9.24%	13.30%	6.73%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	4.33%	0.00%
	8	Federal RFG Relative to Base Case	0.24%	2.27%	0.94%	-0.87%
	9	National LDA/LDT Mix Relative to Base Case	-0.63%	-1.25%	-0.92%	-0.92%
2050	3	100% E10 Relative to Base Case	-0.07%	0.69%	-0.15%	-0.21%
	4	100% E15 Relative to Base Case	0.24%	-2.40%	0.54%	0.75%
	4	100% E15 Relative to 100% E10	0.31%	-3.07%	0.70%	0.97%
	5	100% E15 (T50 Update) Relative to Base Case	-0.32%	-1.85%	0.00%	2.19%
	5	100% E15 (T50 Update) Relative to 100% E10	-0.26%	-2.52%	0.16%	2.41%
	6	Remove LD I/M Relative to Base Case	7.14%	9.09%	3.02%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	15.33%	0.00%
	8	Federal RFG Relative to Base Case	0.82%	3.56%	1.09%	-1.27%
	9	National LDA/LDT Mix Relative to Base Case	-0.50%	-0.57%	-0.26%	-1.28%

Figure 4-49
Fulton County (GA) Sensitivity Case Results
Summer 2011

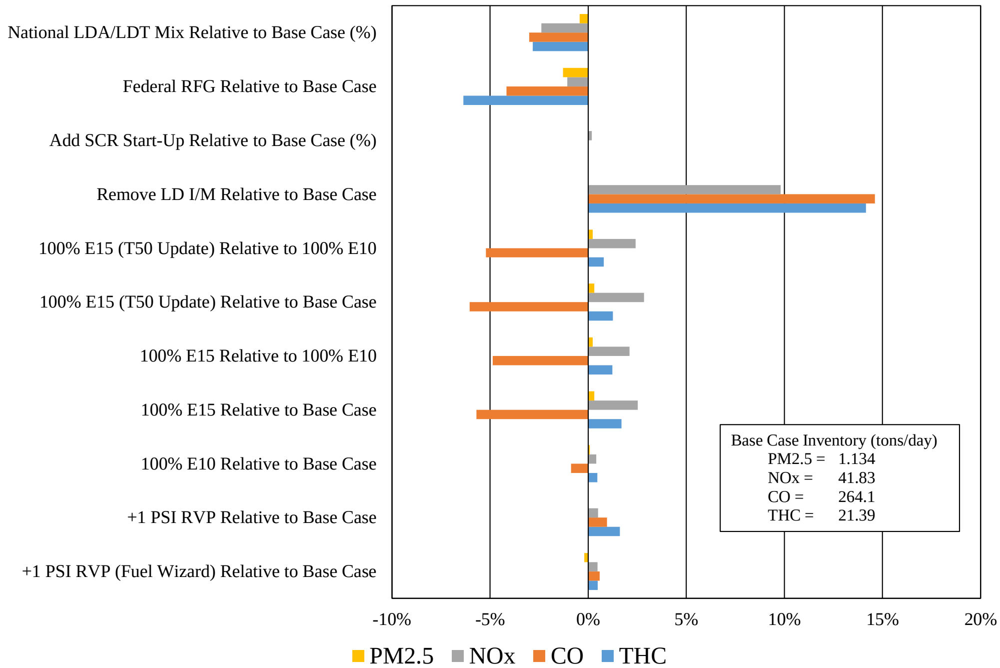


Figure 4-50
Fulton County (GA) Sensitivity Case Results
Summer 2022

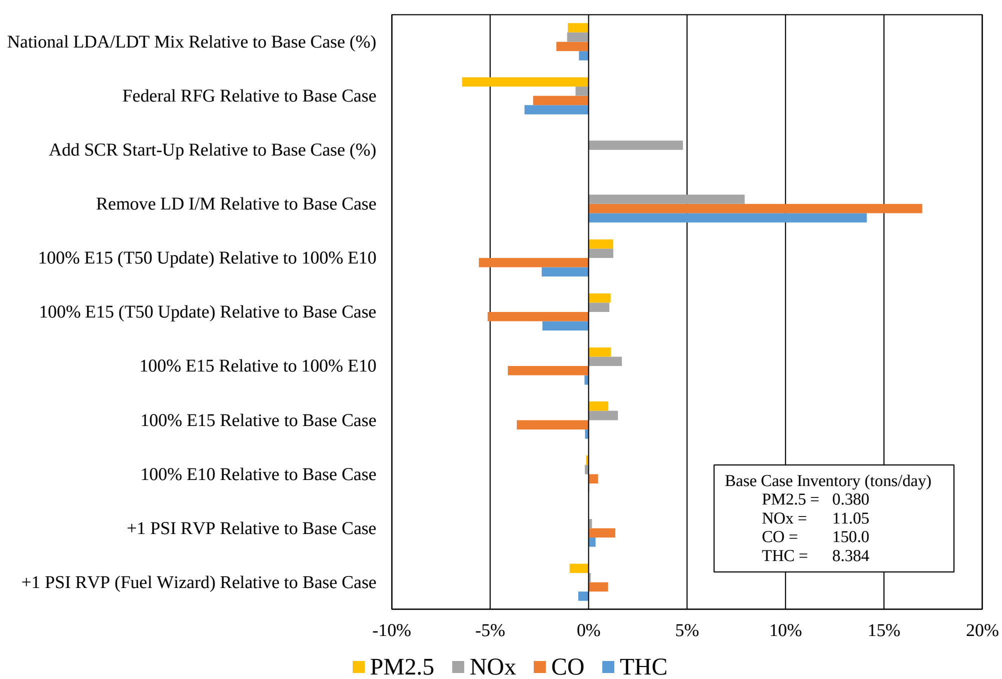


Figure 4-51
Fulton County (GA) Sensitivity Case Results
Summer 2050

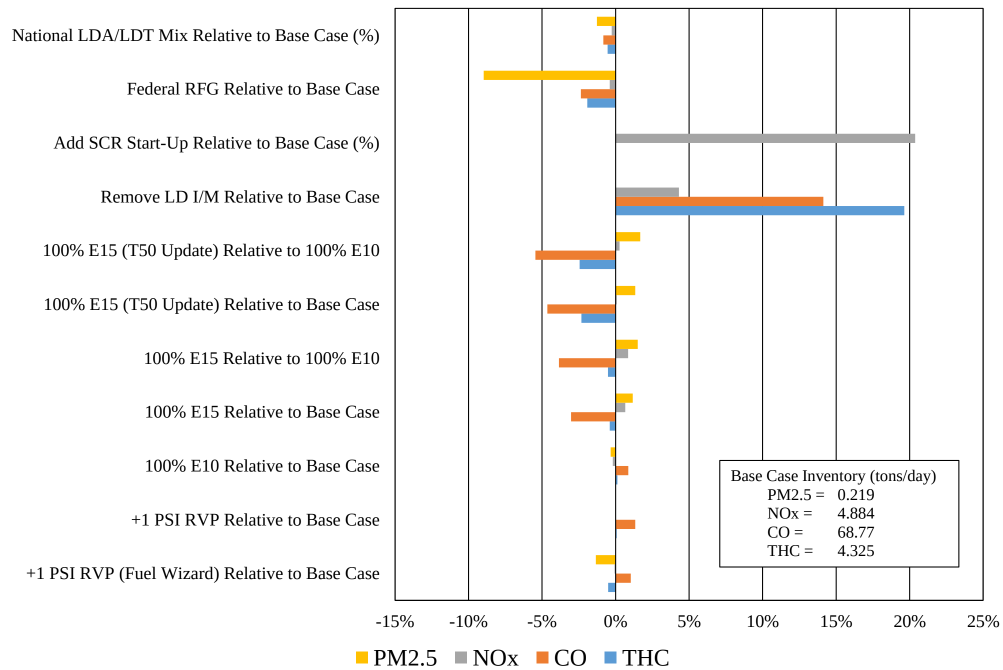


Figure 4-52
Fulton County (GA) Sensitivity Case Results
Winter 2011

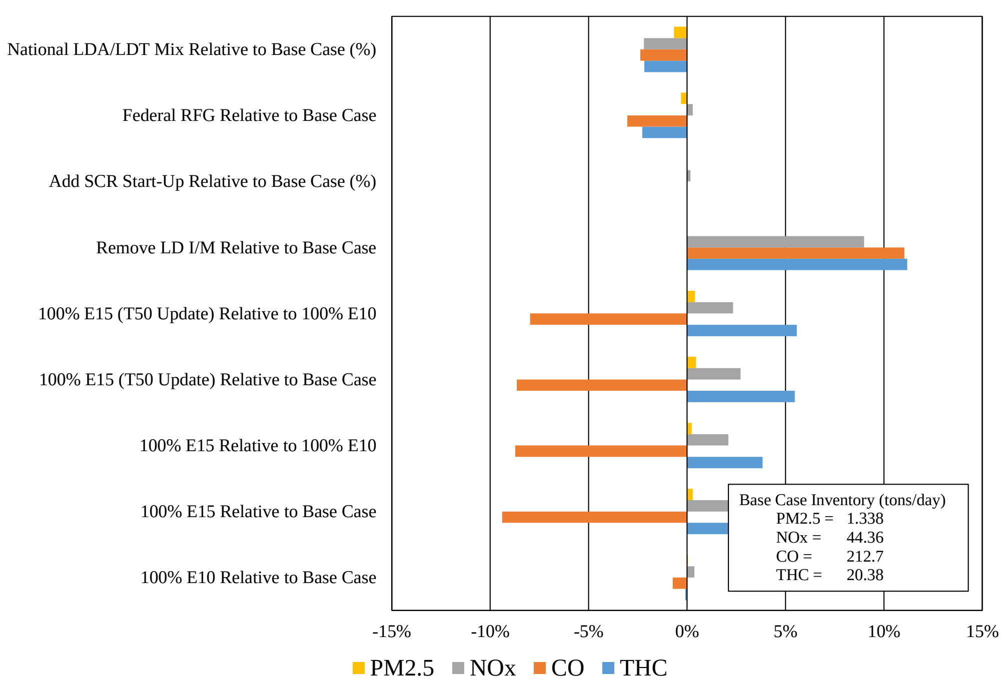


Figure 4-53
Fulton County (GA) Sensitivity Case Results
Winter 2022

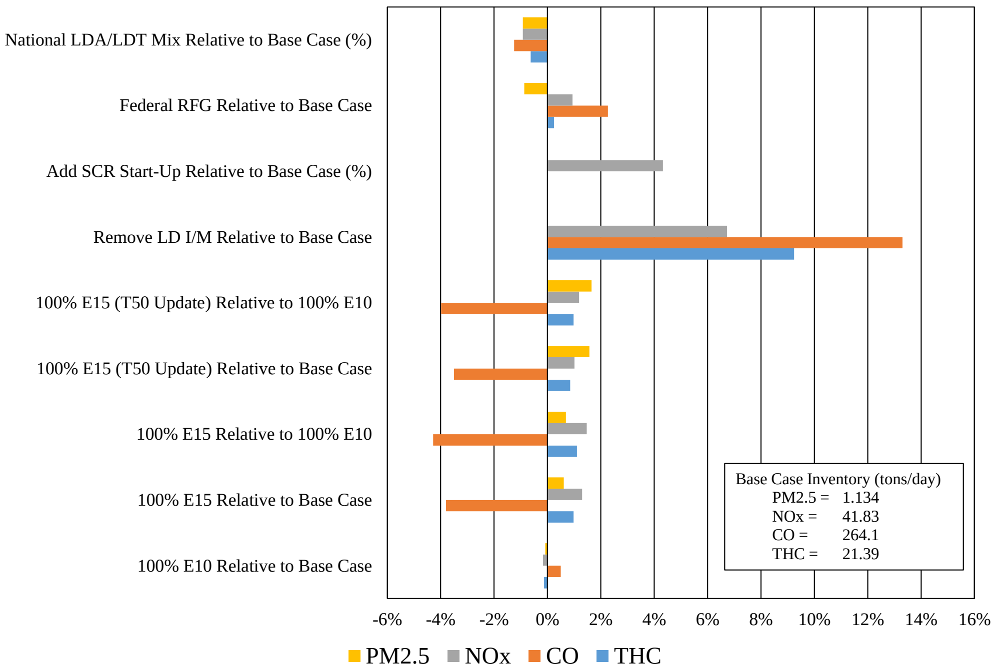
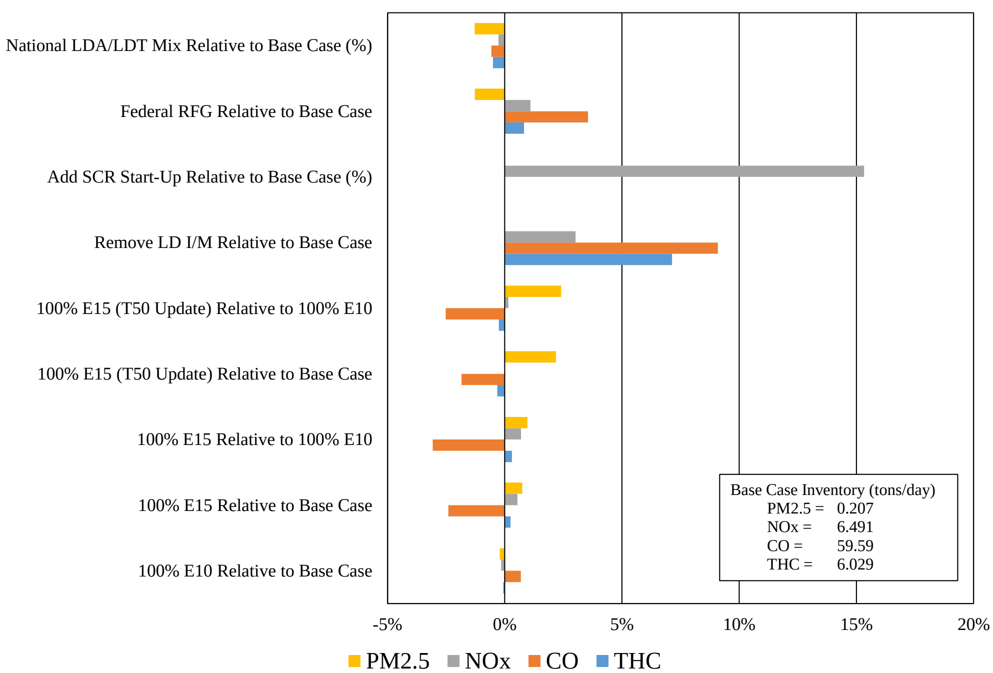


Figure 4-54
Fulton County (GA) Sensitivity Case Results
Winter 2050



For Maricopa County, sensitivity scenario results are presented in Tables 4-16 and 4-17 for summer and winter seasons, respectively. Results by year and season are presented in several figures, as listed below.

- Figure 4-55. Maricopa County (AZ) Sensitivity Case Results, Summer 2011
- Figure 4-56. Maricopa County (AZ) Sensitivity Case Results, Summer 2022
- Figure 4-57. Maricopa County (AZ) Sensitivity Case Results, Summer 2050
- Figure 4-58. Maricopa County (AZ) Sensitivity Case Results, Winter 2011
- Figure 4-59. Maricopa County (AZ) Sensitivity Case Results, Winter 2022
- Figure 4-60. Maricopa County (AZ) Sensitivity Case Results, Winter 2050

Table 4-16 Maricopa County (AZ) Sensitivity Scenario Results, Summer Season						
			Percent Change in On-Road Inventory			
Year	**Scenario**	**Scenario Impact**	**THC**	**CO**	**NOx**	**$PM_{2.5}$**
2011	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	2.39%	0.06%	0.35%	-0.12%
	2	+1 PSI RVP Relative to Base Case	3.04%	0.19%	0.38%	0.00%
	4	100% E15 Relative to Base Case	-0.13%	-4.81%	1.95%	0.07%
	5	100% E15 (T50 Update) Relative to Base Case	-1.03%	-5.50%	2.14%	0.07%
	6	Remove LD I/M Relative to Base Case	16.13%	22.92%	9.84%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	0.10%	0.00%
	8	Conventional Gasoline Relative to Base Case	13.23%	5.80%	9.79%	1.35%
	9	National LDA/LDT Mix Relative to Base Case	7.25%	3.00%	1.22%	5.68%
2022	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	1.30%	0.76%	0.14%	-0.81%
	2	+1 PSI RVP Relative to Base Case	2.05%	0.97%	0.20%	0.00%
	4	100% E15 Relative to Base Case	-1.46%	-3.38%	1.54%	0.39%
	5	100% E15 (T50 Update) Relative to Base Case	-3.82%	-5.21%	1.21%	0.35%
	6	Remove LD I/M Relative to Base Case	12.91%	20.59%	11.71%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	3.24%	0.00%
	8	Conventional Gasoline Relative to Base Case	9.14%	4.20%	2.42%	8.12%
	9	National LDA/LDT Mix Relative to Base Case	10.06%	7.41%	0.39%	7.15%
2050	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	2.45%	0.96%	-0.04%	-0.85%
	2	+1 PSI RVP Relative to Base Case	2.99%	1.21%	0.00%	0.00%
	4	100% E15 Relative to Base Case	-1.15%	-2.95%	0.54%	0.48%
	5	100% E15 (T50 Update) Relative to Base Case	-2.96%	-4.99%	0.18%	0.44%
	6	Remove LD I/M Relative to Base Case	4.00%	13.70%	2.75%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	8.12%	0.00%
	8	Conventional Gasoline Relative to Base Case	14.32%	4.68%	0.74%	8.57%
	9	National LDA/LDT Mix Relative to Base Case	9.99%	9.87%	2.07%	4.25%

Table 4-17 Maricopa County (AZ) Sensitivity Scenario Results, Winter Season						
			Percent Change in On-Road Inventory			
Year	**Scenario**	**Scenario Impact**	**THC**	**CO**	**NOx**	**$PM_{2.5}$**
2011	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	0.54%	2.02%	0.33%	-0.13%
	2	+1 PSI RVP Relative to Base Case	1.08%	1.74%	0.35%	0.00%
	4	100% E15 Relative to Base Case	0.61%	-3.97%	2.01%	0.20%
	5	100% E15 (T50 Update) Relative to Base Case	1.02%	-3.63%	2.13%	0.25%
	6	Remove LD I/M Relative to Base Case	18.19%	19.74%	8.96%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	0.09%	0.00%
	8	Conventional Gasoline Relative to Base Case	3.09%	-0.84%	7.01%	1.16%
	9	National LDA/LDT Mix Relative to Base Case	6.83%	3.51%	1.18%	5.32%
2022	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	-0.53%	1.33%	0.12%	-0.81%
	2	+1 PSI RVP Relative to Base Case	0.19%	1.01%	0.18%	0.00%
	4	100% E15 Relative to Base Case	-1.30%	-2.65%	1.66%	1.05%
	5	100% E15 (T50 Update) Relative to Base Case	-2.37%	-2.92%	1.38%	1.41%
	6	Remove LD I/M Relative to Base Case	14.22%	17.65%	10.28%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	2.86%	0.00%
	8	Conventional Gasoline Relative to Base Case	-0.18%	-3.34%	0.49%	5.26%
	9	National LDA/LDT Mix Relative to Base Case	9.87%	8.11%	0.90%	6.71%
2050	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	-0.52%	1.14%	-0.06%	-0.88%
	2	+1 PSI RVP Relative to Base Case	0.13%	0.78%	0.00%	0.00%
	4	100% E15 Relative to Base Case	-1.53%	-2.24%	0.67%	1.23%
	5	100% E15 (T50 Update) Relative to Base Case	-2.80%	-2.61%	0.27%	1.59%
	6	Remove LD I/M Relative to Base Case	3.43%	10.36%	2.18%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	6.61%	0.00%
	8	Conventional Gasoline Relative to Base Case	-0.18%	-3.64%	-0.02%	5.72%
	9	National LDA/LDT Mix Relative to Base Case	10.09%	10.28%	2.78%	3.74%

Figure 4-55
Maricopa County (AZ) Sensitivity Case Results
Summer 2011

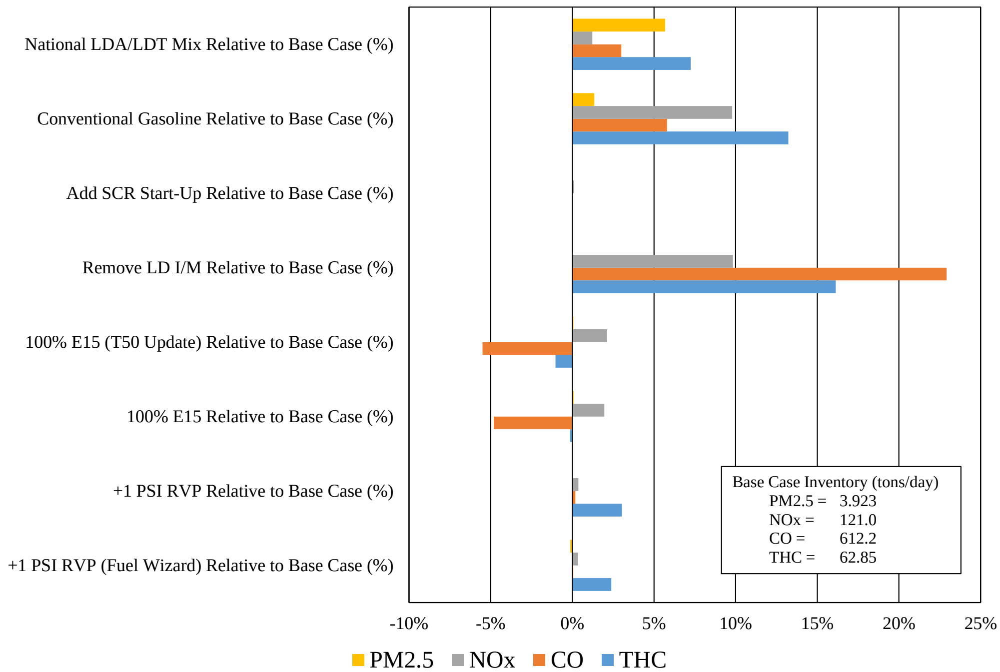


Figure 4-56
Maricopa County (AZ) Sensitivity Case Results
Summer 2022

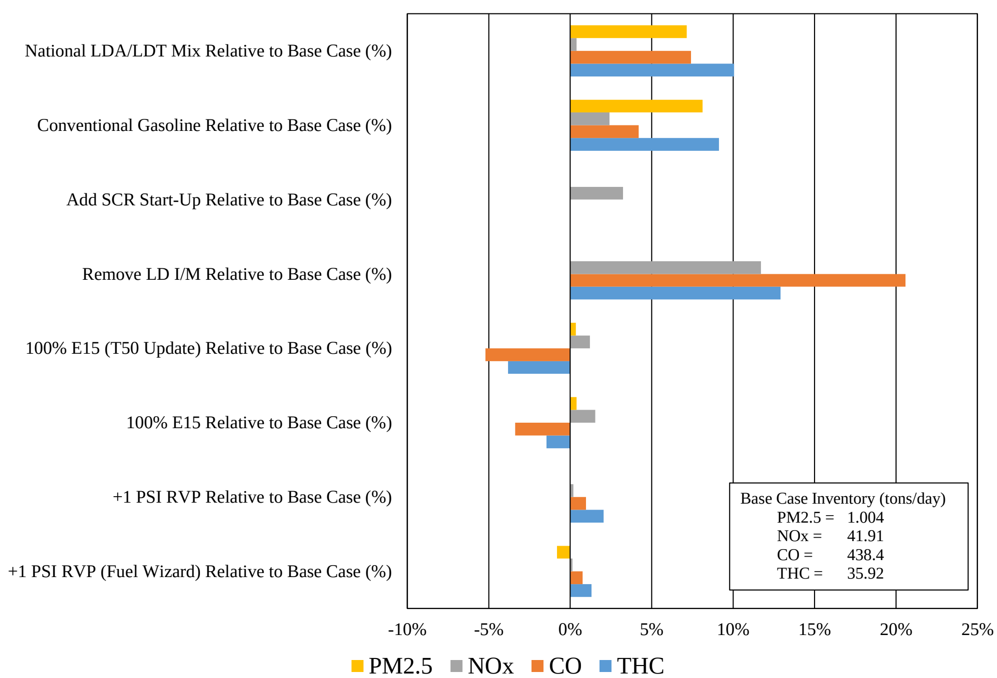


Figure 4-57
Maricopa County (AZ) Sensitivity Case Results
Summer 2050

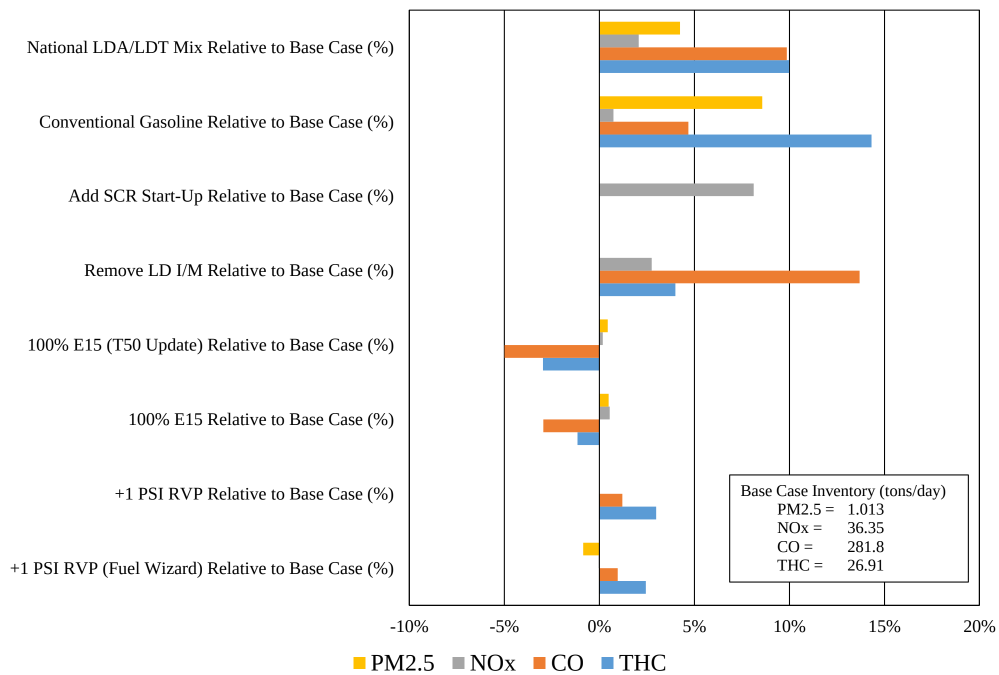


Figure 4-58
Maricopa County (AZ) Sensitivity Case Results
Winter 2011

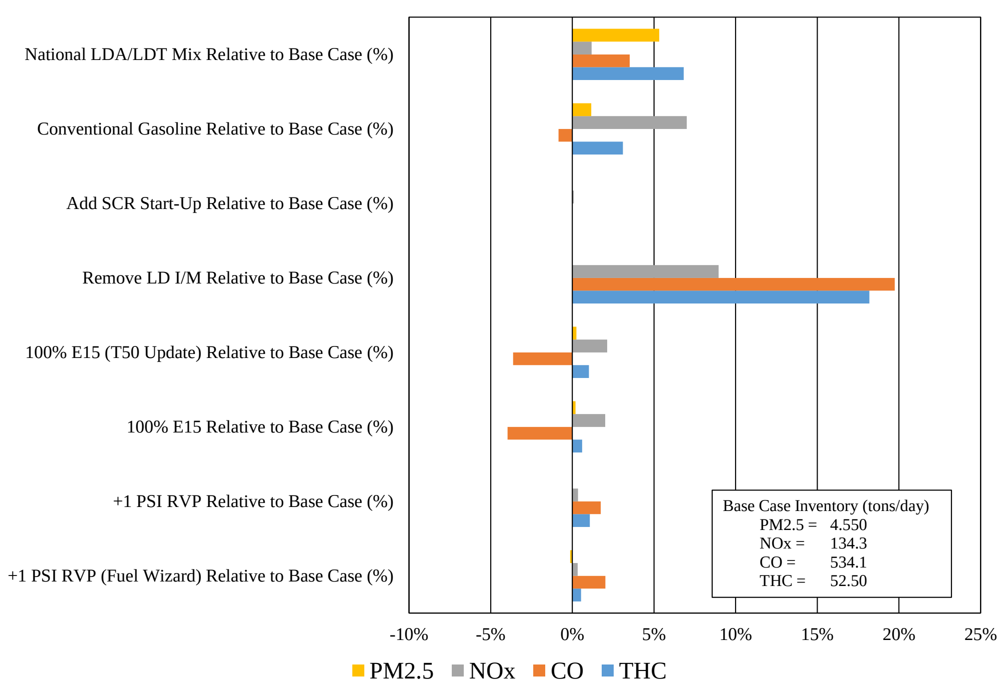


Figure 4-59
Maricopa County (AZ) Sensitivity Case Results
Winter 2022

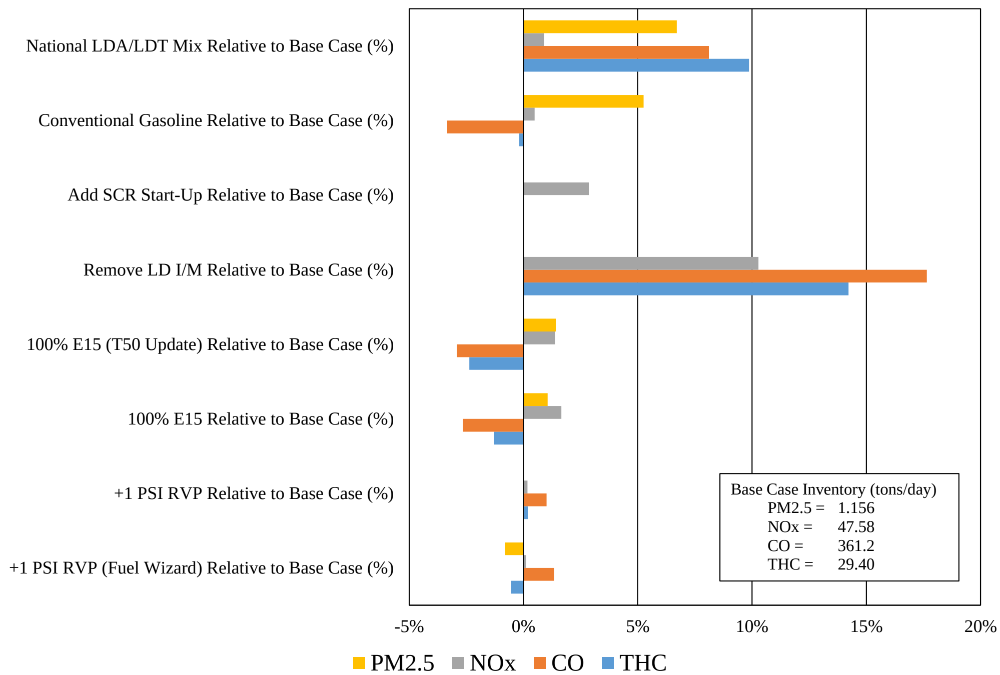
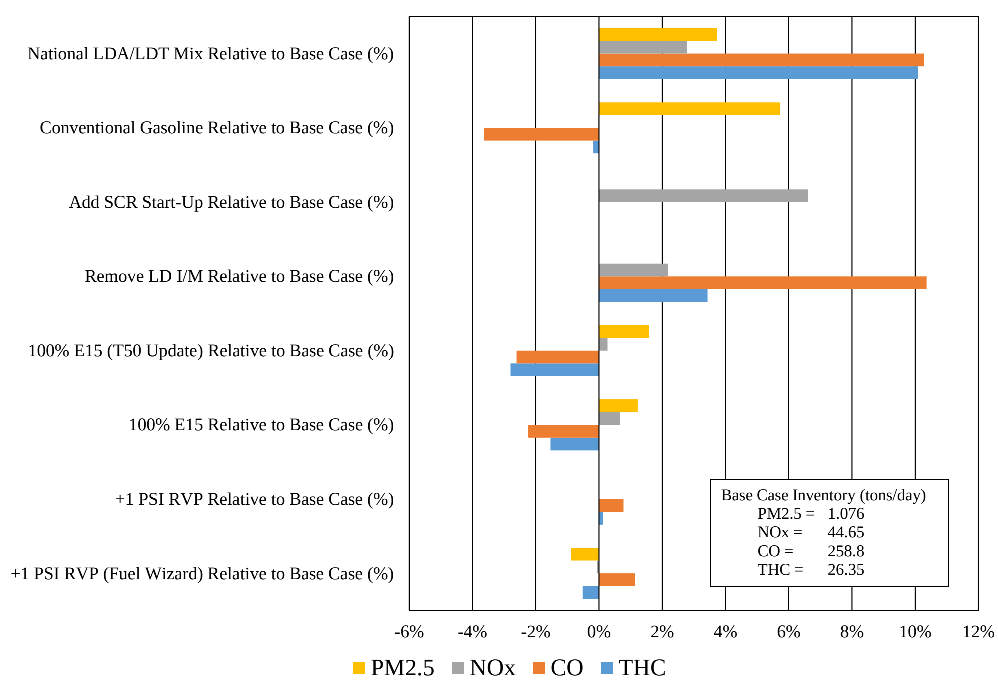


Figure 4-60
Maricopa County (AZ) Sensitivity Case Results
Winter 2050



Sensitivity scenario results for Wayne County are presented in Tables 4-18 and 4-19 for summer and winter seasons, respectively, with the results by year and season presented in the figures listed below.

- Figure 4-61. Wayne County (MI) Sensitivity Case Results, Summer 2011
- Figure 4-62. Wayne County (MI) Sensitivity Case Results, Summer 2022
- Figure 4-63. Wayne County (MI) Sensitivity Case Results, Summer 2050
- Figure 4-64. Wayne County (MI) Sensitivity Case Results, Winter 2011
- Figure 4-65. Wayne County (MI) Sensitivity Case Results, Winter 2022
- Figure 4-66. Wayne County (MI) Sensitivity Case Results, Winter 2050

Table 4-18 Wayne County (MI) Sensitivity Scenario Results, Summer Season						
			Percent Change in On-Road Inventory			
Year	**Scenario**	**Scenario Impact**	**THC**	**CO**	**NOx**	**$PM_{2.5}$**
2011	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	1.11%	0.67%	0.33%	-0.13%
	2	+1 PSI RVP Relative to Base Case	1.99%	0.98%	0.35%	0.00%
	3	100% E10 Relative to Base Case	0.46%	-0.87%	0.34%	0.06%
	4	100% E15 Relative to Base Case	1.20%	-5.38%	2.00%	0.24%
	4	100% E15 Relative to 100% E10	0.74%	-4.54%	1.65%	0.17%
	5	100% E15 (T50 Update) Relative to Base Case	0.90%	-5.70%	2.10%	0.24%
	5	100% E15 (T50 Update) Relative to 100% E10	0.44%	-4.87%	1.75%	0.18%
	6	Add LD I/M Relative to Base Case	-6.44%	-8.95%	-4.84%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	0.03%	0.00%
	8	Federal RFG Relative to Base Case	-5.90%	-6.65%	-1.46%	-1.56%
	9	National LDA/LDT Mix Relative to Base Case	0.32%	0.30%	0.16%	6.75%
2022	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	0.09%	1.00%	0.09%	-0.71%
	2	+1 PSI RVP Relative to Base Case	0.82%	1.31%	0.14%	0.00%
	3	100% E10 Relative to Base Case	0.08%	0.52%	-0.16%	-0.12%
	4	100% E15 Relative to Base Case	-0.46%	-3.56%	1.09%	0.85%
	4	100% E15 Relative to 100% E10	-0.54%	-4.06%	1.25%	0.97%
	5	100% E15 (T50 Update) Relative to Base Case	-1.80%	-4.56%	0.89%	0.94%
	5	100% E15 (T50 Update) Relative to 100% E10	-1.88%	-5.06%	1.05%	1.06%
	6	Add LD I/M Relative to Base Case	-7.11%	-13.35%	-4.77%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	1.98%	0.00%
	8	Federal RFG Relative to Base Case	-3.76%	-5.76%	-1.67%	-8.21%
	9	National LDA/LDT Mix Relative to Base Case	0.02%	0.22%	0.08%	6.27%
2050	1	+1 PSI RVP (Fuel Wizard) Relative to Base Case	0.82%	1.05%	-0.03%	-0.93%
	2	+1 PSI RVP Relative to Base Case	1.25%	1.36%	0.00%	0.00%
	3	100% E10 Relative to Base Case	0.36%	0.94%	-0.14%	-0.32%
	4	100% E15 Relative to Base Case	-1.01%	-2.94%	0.43%	1.00%
	4	100% E15 Relative to 100% E10	-1.36%	-3.85%	0.57%	1.33%
	5	100% E15 (T50 Update) Relative to Base Case	-2.03%	-4.07%	0.22%	1.11%
	5	100% E15 (T50 Update) Relative to 100% E10	-2.38%	-4.97%	0.36%	1.44%
	6	Add LD I/M Relative to Base Case	-3.48%	-11.20%	-2.12%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	5.58%	0.00%
	8	Federal RFG Relative to Base Case	-2.60%	-5.76%	-1.06%	-10.89%
	9	National LDA/LDT Mix Relative to Base Case	-0.02%	0.11%	0.02%	4.94%

Table 4-19 Wayne County (MI) Sensitivity Scenario Results, Winter Season						
			Percent Change in On-Road Inventory			
Year	Scenario	Scenario Impact	THC	CO	NOx	$PM_{2.5}$
2011	3	100% E10 Relative to Base Case	-0.23%	-0.74%	0.32%	0.06%
	4	100% E15 Relative to Base Case	3.67%	-9.54%	2.03%	0.37%
	4	100% E15 Relative to 100% E10	3.91%	-8.87%	1.70%	0.31%
	5	100% E15 (T50 Update) Relative to Base Case	4.20%	-9.29%	2.08%	0.43%
	5	100% E15 (T50 Update) Relative to 100% E10	4.44%	-8.61%	1.75%	0.38%
	6	Add LD I/M Relative to Base Case	-4.46%	-5.58%	-4.51%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	0.03%	0.00%
	8	Federal RFG Relative to Base Case	-2.78%	-6.47%	-0.52%	-1.36%
	9	National LDA/LDT Mix Relative to Base Case	0.22%	0.18%	0.16%	4.66%
2022	3	100% E10 Relative to Base Case	-0.19%	0.55%	-0.15%	-0.12%
	4	100% E15 Relative to Base Case	1.35%	-3.75%	1.02%	0.83%
	4	100% E15 Relative to 100% E10	1.54%	-4.27%	1.18%	0.95%
	5	100% E15 (T50 Update) Relative to Base Case	1.35%	-3.56%	0.95%	1.23%
	5	100% E15 (T50 Update) Relative to 100% E10	1.55%	-4.09%	1.10%	1.35%
	6	Add LD I/M Relative to Base Case	-4.50%	-8.88%	-4.13%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	1.84%	0.00%
	8	Federal RFG Relative to Base Case	-0.02%	0.04%	-0.51%	-6.14%
	9	National LDA/LDT Mix Relative to Base Case	0.02%	0.12%	0.07%	4.19%
2050	3	100% E10 Relative to Base Case	-0.15%	0.64%	-0.13%	-0.32%
	4	100% E15 Relative to Base Case	0.48%	-1.99%	0.40%	0.99%
	4	100% E15 Relative to 100% E10	0.63%	-2.61%	0.53%	1.31%
	5	100% E15 (T50 Update) Relative to Base Case	0.37%	-1.72%	0.29%	1.52%
	5	100% E15 (T50 Update) Relative to 100% E10	0.52%	-2.34%	0.42%	1.85%
	6	Add LD I/M Relative to Base Case	-1.58%	-5.71%	-1.64%	0.00%
	7	Add SCR Start-Up Relative to Base Case	0.00%	0.00%	4.71%	0.00%
	8	Federal RFG Relative to Base Case	0.58%	2.60%	-0.47%	-8.31%
	9	National LDA/LDT Mix Relative to Base Case	0.02%	0.06%	0.02%	2.72%

Figure 4-61
Wayne County (MI) Sensitivity Case Results
Summer 2011

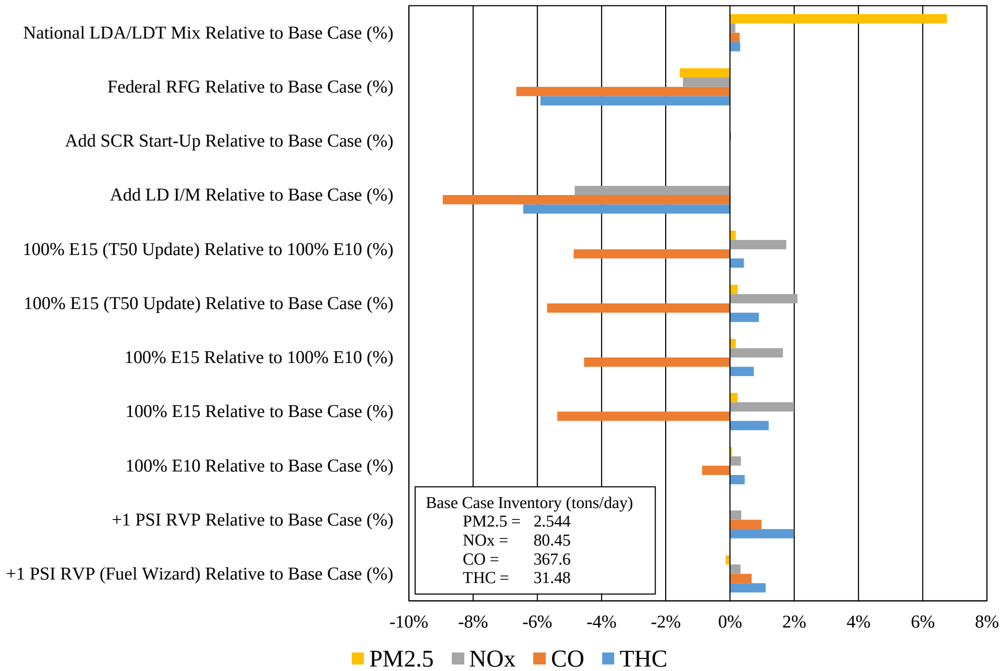


Figure 4-62
Wayne County (MI) Sensitivity Case Results
Summer 2022

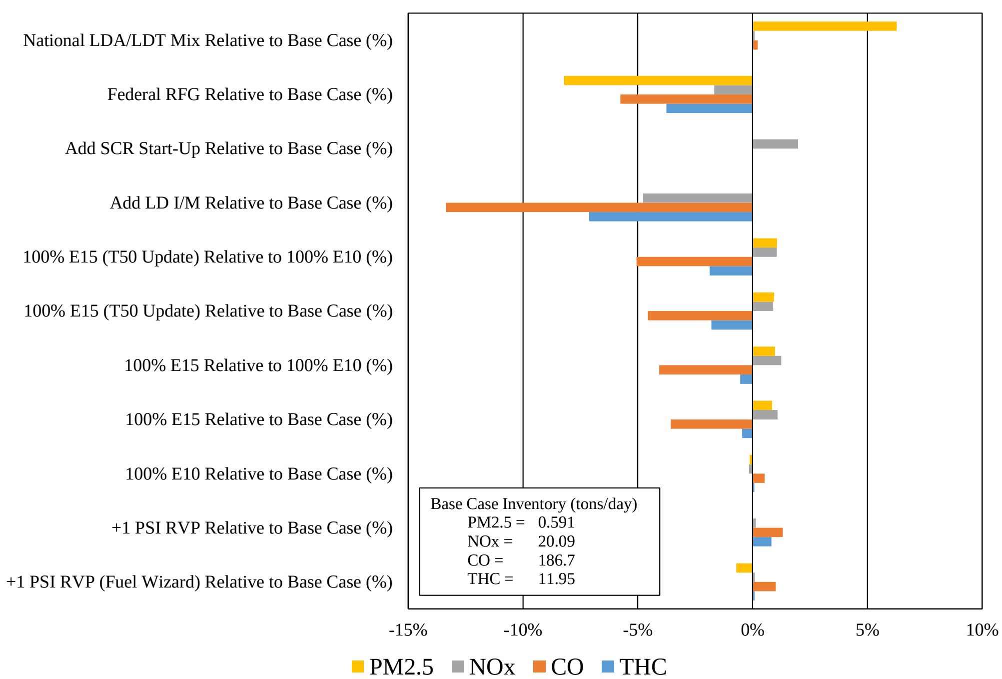


Figure 4-63
Wayne County (MI) Sensitivity Case Results
Summer 2050

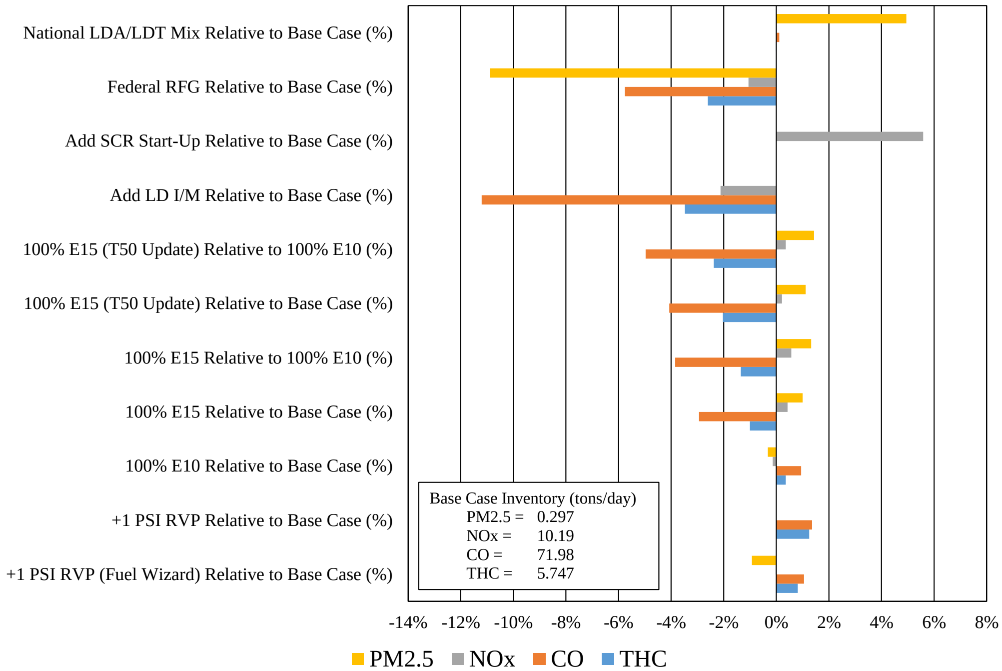


Figure 4-64
Wayne County (MI) Sensitivity Case Results
Winter 2011

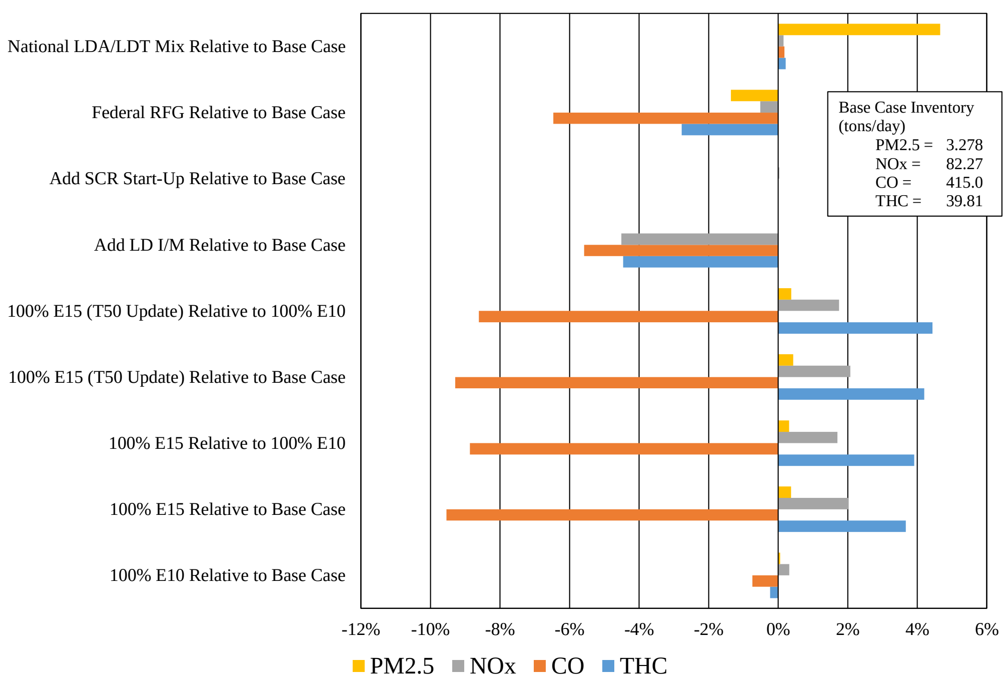


Figure 4-65
Wayne County (MI) Sensitivity Case Results
Winter 2022

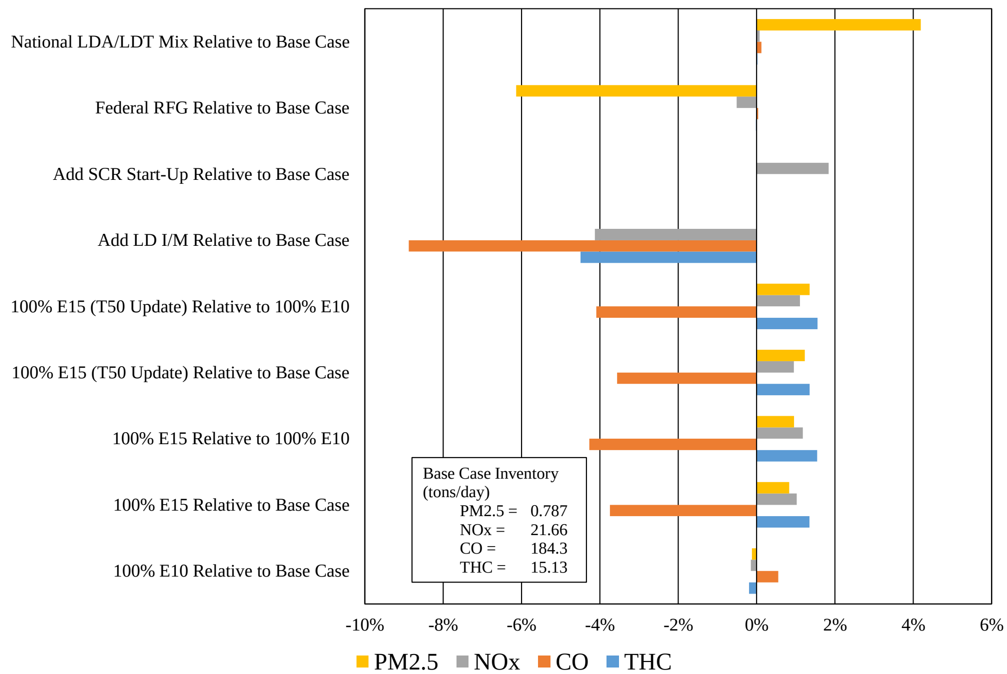
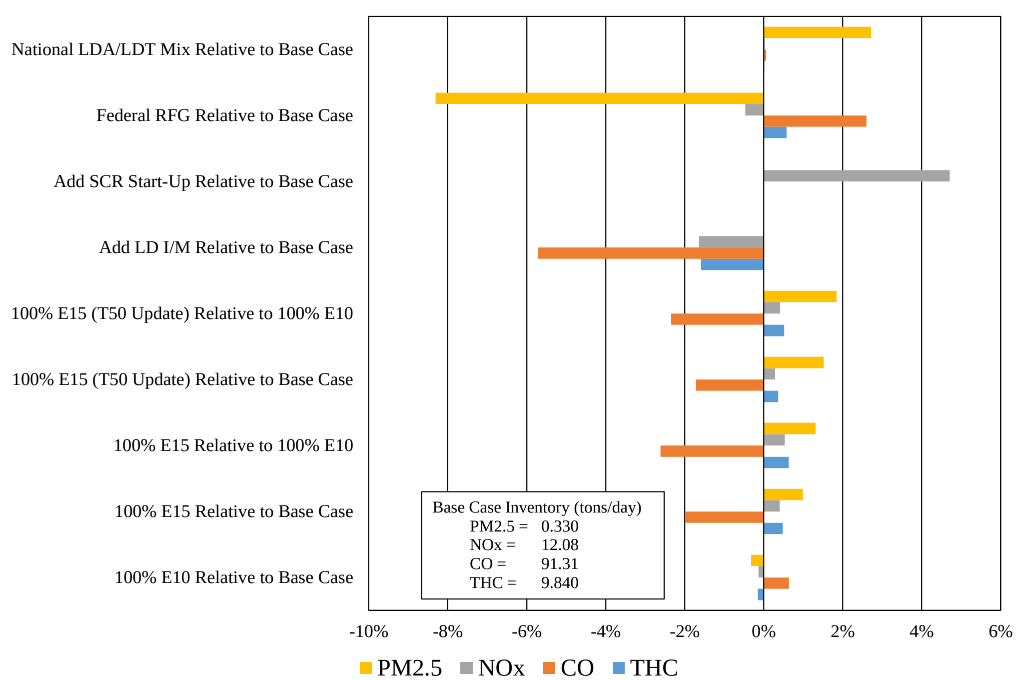


Figure 4-66
Wayne County (MI) Sensitivity Case Results
Winter 2050



Key observations from the collective results across all three locations are summarized below.

- RVP limits, typically enacted as summer season HC control strategy, have a modest impact in the THC inventory over the change in RVP examined herein. Increasing RVP by 1 PSI results in a 0 to 3 percent increase in summer season THC emissions. Increasing RVP results in an increase in evaporative THC which is countered, in part, by a reduction in exhaust THC.*

- The winter season RVP cap in Maricopa County (AZ) was enacted as a CO emissions control measure. The winter season modeling results for this county show a 0 to 2 percent increase in CO emissions for a 1 PSI increase in RVP.

- The 100% E15 inventory impact relative to the 100% E10 case yields an increase in NOx and PM of 0 to 2 percent. Conversely, the E15 scenario (relative to E10) yields a CO inventory reduction from 2 to 9 percent. The THC inventory impact is mixed with a range of impact from -2 to +6 percent.

- The presence of light-duty I/M reduces the THC and CO inventories in the range of 2 to 20 percent; I/M reduces the NOx inventory by 2 to 9 percent.

- Adding in the NOx startup exhaust for SCR-equipped heavy-duty diesel vehicles increases NOx; the increase in NOx emissions gets larger as more SCR-equipped vehicles are phased in. By 2050, the NOx impact on the on-road inventory is an increase between 5 and 20 percent; the variation in impact by location tracks with the proportion of heavy-duty diesel vehicle population, which is the activity basis for determining emissions in this case.

- The impact of reformulated gasoline over conventional gasoline results in a change in THC in the range of -14 to +1 percent, CO in the range of -7 to +4 percent, NOx in the range of -10 to +1 percent and $PM_{2.5}$ in the range of -10 to -1 percent.

- Changing the mix of passenger cars and light-trucks to the national-average proportions had an impact of 10 percent or less on the inventory, with the greatest impact in Maricopa County, which differed most from the national average (see Table 4-7).

Additional sensitivity scenario results are provided in Appendix B, which contains scenario inventories (in tons per day) and scenario impacts in both tons per day and in percent. Appendix B reports results by vehicle class and by exhaust and evaporative components separately.

* Caution needs to be applied in extrapolating from these results, as the underlying method of modeling evaporative emissions canister breakthrough is non-linear.

4.4 Final Remarks

The Base Case inventory results show a substantial reduction in emissions over time related to the continued implementation of already enacted federal control programs. For fuels, those programs include national sulfur and ethanol requirements for gasoline. For vehicles, those programs include light-duty Tier 3 standards, the Mobile Source Air Toxics (MSAT) rule and heavy-duty diesel 2007 and later model year standards. The magnitude of the Base Case emission inventory reductions—observed across all three study locations—dwarfs the emissions impacts observed in the sensitivity scenarios.

- By 2022, the average decline in THC, NOx, $PM_{2.5}$, and CO emissions from 2011 under the Base Case is 55%, 71%, 73%, and 43%.

- By 2050, the average decline in THC, NOx, $PM_{2.5}$, and CO emissions from 2011 under the Base Case is 69%, 81%, 82%, and 68%.

Local fuel and I/M programs—evaluated as part of the sensitivity cases—provide relatively smaller impacts on emissions inventories in comparison to the Base Case reductions noted above for the time period through calendar year 2050. Most of the local control programs currently on the books were enacted when MOBILE was used as the tool for evaluating the benefits of regulatory policies and these preceded several key federal control programs which are now part of MOVES2014.

For example, the federal Reformulated Gasoline program was originally defined as part of the 1990 Clean Air Act Amendments. Since then, there have been two rounds of federal sulfur control in gasoline (i.e., Tier 2 and Tier 3), a national ethanol mandate (i.e., RFS and RFS2) and the MSAT rule controlling benzene content. The relative benefit of the reformulated gasoline program in the current regulatory context is diminished.

Local summer RVP control programs represent a second example. These historically have been assigned significant reductions in HC on-road emissions. A 2007 demonstration of need for a 7 PSI cap in Clark County, Nevada (relative to a 9.0 PSI baseline) estimated a greater than 20 percent reduction in on-road, summer-season HC inventory over the 2008 to 2018 timeframe,[*72] whereas, the sensitivity scenarios analyses using MOVES2014 in this study show a much more modest impact of RVP changes on on-road THC emissions.

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[*] The inventory impact analysis relied on the MOBILE6 model.

5. COMPARATIVE ANALYSES OF FUEL FACTOR EFFECTS IN MOVES2014

One of the major updates incorporated into MOVES2014 was the newly developed methods for estimating the impacts of gasoline parameter variation on exhaust emissions from the latest technology vehicles. These new methods consisted of sulfur-content impacts and non-sulfur impacts applied to 2001 and later model year vehicles. These methods were assessed by comparing them with exhaust measurements drawn from other fuel vehicle test programs not used in the development of MOVES2014. The goal of the comparative analyses was to assess the accuracy and reasonableness of the new MOVES methods against data from recent programs independent from the model's development.

5.1 Independent Studies & Analysis Methods

Suitable studies were identified and selected based on the representativeness of test vehicles and fuels covered by the newly developed MOVES methods. Four studies were ultimately selected for inclusion the analyses: CRC E-98, CRC E-74b, EPA-Auto Tier 2 Test Program, and API Sulfur Reversibility. These studies are summarized in Table 5-1. CRC E-94-1a was considered as a candidate study but was dropped due to inadequate fuel parameter reporting.[73]

Table 5-1 Summary Studies Used in Comparative Analyses						
Study	**Fuels**	**Variables of Interest**	**Fleet**	**Average Odometer**	**Pollutants**	**Test Cycle**
CRC E-98[74]	3	RVP, Ethanol, Distillation Points, Aromatics	15 Tier 2 vehicles	13,160	THC, CO, NOx, PM	LA-92
CRC E-74b[75]	5	RVP, Ethanol, Distillation Points	5 NLEV, 7 Tier 2 vehicles	85,286 & 59,543 (NLEV & Tier 2 vehicles)	THC, CO, NOx	FTP
EPA-Auto Tier 2 Test Program[76,77*]	4	RVP, Sulfur, CaRFG[a]	9 Tier 2 vehicles	120,000 (laboratory aged)	THC, CO, NOx	FTP
API Sulfur Reversibility Study[78]	2	Sulfur	6 Tier 2 vehicles	120,000 to 150,000 (laboratory aged)	THC, CO, NOx	FTP
a. CaRFG = California reformulated gasoline						

The analyses consisted of the several elements, as summarized below.

1. Potential data exclusions were considered for each study. Data exclusions were made for values that fell outside the valid range of fuel parameter variation used to support the MOVES methods. For example, fuels with a RVP value outside the range used to develop MOVES fuel corrections were eliminated from consideration in this analysis. Data exclusions, when applicable, are described within the summary of each study.

2. The MOVES method determines the relative change in exhaust emissions between two gasolines (i.e., scenario and reference cases). Thereby, the fuels of each study were grouped into a unique set of fuel pairs for evaluation. For each fuel pair, the relative change in exhaust emissions was estimated using the MOVES model and compared against the relative change in exhaust emissions observed (i.e., the overall fleet average).

3. The emissions impact from changes in sulfur and non-sulfur gasoline parameters were evaluated separately as the underlying methods and data sources are different. Non-sulfur modeling specifically refers to the MOVES2014 method for adjusting exhaust emissions for variation in ethanol, aromatics, RVP, T50 and T90.

[*] The only test study documentation is the information contained in the mobile source air toxics (MSAT) rulemaking regulatory impact analysis (RIA); see Reference 77.

4. Alternate forms of the non-sulfur correction equation used in MOVES2014 also were examined against the independent study data. These alternative statistical models, developed previously by EPA and DOE using the same underlying EPAct test program supporting the MOVES method, differ in their development steps and in the number of significant "terms" defined in the regression equation.[79,80] These models are termed "Gunst 17-term," "Gunst 16-term," "Gunst Reduced," and "EPA 16-term."[*] Moreover, it is noteworthy that EPA's analysis of EPAct—supporting the MOVES2014 non-sulfur corrections and the EPA 16-term model—excluded specific vehicle-pollutant combinations,[†] whereas the Gunst models did not employ vehicle-pollutant exclusions.

5. Exhaust impacts were separately evaluated for startup and running exhaust as these two modes are handled differently by MOVES. For start exhaust, it is notable that EPA applied different definitions of what constitutes the start portion of exhaust for sulfur and non-sulfur methods. For non-sulfur fuel adjustments, the cold start bag or phase (i.e., Phase 1) of the test cycle was used to model start exhaust (i.e., fuel impacts are modeled as the change in Phase 1 exhaust). For the sulfur fuel adjustments, start exhaust was defined by the difference of the cold and warm start bags or phases (i.e., Phase 1 minus Phase 3). These differing definitions of start exhaust were retained in this analysis.

6. The *mean absolute error* (or MAE) was used, when applicable, to provide a comparative statistical assessment across multiple study results. The MAE measures the average magnitude of the errors in a set of forecasts and is defined by the mean of the absolute value of the error over a set of n predictions.[‡]

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|error_i\right|$$

7. A statistical analysis of the test results for all vehicles was performed. Test fleet average emission rates were derived from the average of the log-transformed vehicle emissions. Multiple tests on the same vehicle were averaged before the log transformation. Zero values (i.e., below detection limits) were reset to the value halfway between zero and the lowest measured for each pollutant.

8. The emission rate method for start exhaust was distinctly defined for sulfur and non-sulfur effects in a manner consistent with that used to support MOVES2014

[*] There is also the "11-term EPA" equation defined in the EPA source reference, which is effectively that incorporated into MOVES2014. The 11-term EPA equation was reviewed but excluded from this document as the results were redundant with those from the MOVES2014 model.
[†] EPA dropped one vehicle each for start (Phase 1) and running (Phase 2) NOx, and two vehicles for running (Phase 2) THC. The statistical analysis and logic supporting these exclusions are provided in the EPA's EPAct data analysis report (Reference 80).
[‡] Error is defined by the difference between the model-predicted exhaust impact and the study fleet average exhaust impact.

fuel effects modeling for 2001 and later model years. Specifically, for non-sulfur effects, the start exhaust emission rate is based on the cold-start phase (i.e., Phase 1) of the underlying test cycle. For sulfur effects, the start exhaust emission rate is based on the difference between the cold- and hot-start phases of the test cycle (i.e., Phase 1 minus Phase 3).[37] [*]

Provided below is a brief summary of each comparative study, discussing the fuels, vehicles, and data exclusions.

5.1.1 CRC E-98

CRC's E-98/A-80 test program examined the exhaust emissions impacts from operating 15 Tier 2 vehicles on three test fuels. The fuels and vehicle fleet are summarized in Tables 5-2 and 5-3, respectively. The CRC E-98 15-vehicle fleet is the same as that used in the EPAct test program; the comparative analysis thereby minimizes the variability attributable to differences in test vehicle characteristics that would be otherwise observed if using data drawn from a fully independent test program. With that understood, and as previously noted, the EPA analysis of EPAct data excluded certain vehicle-pollutant combinations, and thereby comparisons between CRC E-98 test fleet mean emission rates (including all test data) and EPA-developed models do have different underlying test fleets for the cases of Phase 1 NOx, Phase 2 NOx, and Phase 2 THC exhaust.

Other key elements of the use of the E-98 test program are listed below.

1. There were no data exclusions for the CRC E-98 test program analysis.

2. Two fuel pairs were examined: Fuel 1 to Fuel 2 (comparison of the E10 fuel relative to E0), and Fuel 2 to Fuel 3 (comparison of the E15 fuel relative to E10).

3. The alternate non-sulfur correction models of "Gunst 17-term," "Gunst 16-term," "Gunst Reduced," and "EPA 16-term" were included.

Table 5-2
CRC E-98 Test Fuels

Parameter	Fuel 1	Fuel 2	Fuel 3
Ethanol (%)	0	10.1	15.8
Aromatics (%)	35.4	27.4	24.6
RVP (PSI)	7.21	9.64	7.55
T50 (oF)	225.5	175.5	215.1
T90 (oF)	340.5	304.2	331.1

[*] The emission rate for running exhaust was taken from the Phase 2 portion of the exhaust test cycle for both sulfur and non-sulfur effects, consistent with the MOVES2014 methods.

Table 5-3 CRC E-98 Vehicle Fleet					
Brand	**Model**	**Model Year**	**Engine**	**Tier 2 Bin**	**Starting Odometer**
Chevrolet	Cobalt	2008	2.4L I4	5	12,743
Chevrolet	Impala FFV	2008	3.5L V6	5	12,356
Saturn	Outlook	2008	3.6L V6	5	13,002
Chevrolet	Silverado FFV	2008	5.3L V8	5	14,579
Toyota	Corolla	2008	1.8L I4	5	13,005
Toyota	Camry	2008	2.4L I4	5	12,239
Toyota	Sienna	2008	3.5L V6	5	13,151
Ford	Focus	2008	2.0L I4	4	12,377
Ford	Explorer	2008	4.0L V6	4	14,989
Ford	F-150 FFV	2008	5.4L V8	8	15,273
Dodge	Caliber	2008	2.4L I4	5	12,308
Jeep	Liberty	2008	3.7L V6	5	12,480
Honda	Civic	2008	1.8L I4	5	13,441
Honda	Odyssey	2008	3.5L V6	5	12,641
Nissan	Altima	2008	2.5L I4	5	12,823

A summary of the calculated test fleet mean emission rates is presented in Table 5-4.

Table 5-4 CRC E-98 Test Fleet Mean Emission Rates by Fuel				
Exhaust Phase	**Pollutant**	**Fuel 1**	**Fuel 2**	**Fuel 3**
Phase 1	THC (g/mi)	0.632	0.360	0.528
	CO (g/mi)	4.946	4.469	4.429
	NOx (g/mi)	0.088	0.086	0.072
	PM (mg/mi)	4.645	1.912	3.381
Phase 2	THC (g/mi)	0.0110	0.0111	0.0118
	CO (g/mi)	0.3927	0.2554	0.2819
	NOx (g/mi)	0.0100	0.0093	0.0102
	PM (mg/mi)	0.5192	0.4251	0.5396

5.1.2 CRC E-74b

CRC's E-74b test program examined the impacts of 15 Tier 1, LEV, and Tier 2 vehicles on seven test fuels. The fuels and vehicle fleet are summarized in Tables 5-5 and 5-6, respectively. Ambient temperature (50 and 75 °F) was a variable in this study. Because the E-74b project determined significantly different fuel effects by vehicle standard, the processing of the E-74b data was completed for NLEV and Tier 2 vehicles separately.

Data from CRC E-74b that were excluded from this exercise are listed below along with the reason(s) for the exclusion.

1. The 50-degree test data were excluded to avoid the confounding impacts of temperature variation on exhaust emissions—in particular, the RVP-temperature interactions.

2. Vehicles 1 through 3 were certified to Tier 1 standards and were excluded because they were not covered by the MOVES methods being evaluated in this exercise.

3. Five out of seven fuels were examined in the analysis. Fuels 2 and 5 were excluded because the RVP specifications were well in excess of the maximum RVP used in the MOVES method.*

Table 5-5
CRC E-74b Test Fuels

Parameter	Fuel 1	Fuel 2	Fuel 3	Fuel 4	Fuel 5	Fuel 6	Fuel 7
Ethanol (%)	9.42	9.03	0.00	20.38	0.00	0.00	9.54
Aromatics (%)	23.6	22.5	23.4	21.5	24.2	22.1	24.4
RVP (PSI)	8.79	13.30	9.10	8.47	12.76	6.95	7.30
T50 (oF)	189.8	165.4	191.0	159.6	189.1	197.9	195.0
T90 (oF)	319.0	322.1	316.5	313.7	316.3	313.6	317.0

* The 27 EPAct fuels supporting the MOVES method included a maximum RVP specification of 10.3 PSI.

Table 5-6 CRC E-74b Vehicle Fleet						
Vehicle No	**Model Year**	**Make**	**Exhaust Standard**	**Standards [a] (g/mile)**	**Cold CO Standards (g/mile)**	**Evap Standard**
001	1994	Chevrolet	Tier 1 LDV	.31/4.2/.6	N/A	Pre Enhanced
002	1996	Ford	Tier 1 LDV	.31/4.2/.7	10.0	Enhanced
003	1995	Jeep	Tier 1 LDT2	0.40/5.5/0.97	N/A	Pre Enhanced
004	1999	Honda	NLEV LEV	.09/4.2/.3	10.0	Enhanced/ORVR
005	2001	Toyota	NLEV LEV	.09/4.2/.3	10.0	Enhanced/ORVR
006	2002	Nissan	NLEV ULEV	.055/2.1/.3	10.0	Enhanced/ORVR
007	2001	Dodge	NLEV LEV LDT2	.13/5.5/.5	12.5	Enhanced/ORVR
008	2002	Chevrolet	NLEV LEV LDT2	.13/5.5/.5	12.5	Enhanced/ORVR
009	2004	Dodge	Tier 2 Bin 5	.09/4.2/.07	10.0	Enhanced/ORVR
010	2004	Chevrolet	Tier 2 Bin 5	.09/4.2/.07	10.0	Enhanced/ORVR
011	2004	Toyota	Tier 2 Bin 9	.09/4.2/.30	10.0	Near Zero/ORVR
012	2006	Ford	Tier 2 Bin 5	.09/4.2/.07	10.0	Near Zero/ORVR
013	2004	Dodge	Tier 2 Bin 10 LDT	.23/6.4/.60	12.5	Enhanced/ORVR
014	2004	Ford	Tier 2 Bin 9	.09/4.2/.30	10.0	Near Zero/ORVR
015	2004	Toyota	Tier 2 Bin 5	.09/4.2/.07	10.0	Near Zero/ORVR
a. Standards are given as NMHC/CO/NOx						

From the test fuels, five distinct fuel pairs were evaluated:

- Fuel 3 to Fuel 1 (E0 to E10);
- Fuel 6 to Fuel 7 (E0 to E10);
- Fuel 1 to Fuel 4 (E10 to E20);
- Fuel 3 to Fuel 6 (RVP change); and
- Fuel 1 to Fuel 7 (RVP change).

Table 5-7 summarizes the calculated test fleet mean emission rates.

Table 5-7 CRC E-74b Test Fleet Mean Emission Rates (g/mi) by Fuel							
Standard	**Exhaust Phase**	**Pollutant**	**Fuel 1**	**Fuel 3**	**Fuel 4**	**Fuel 6**	**Fuel 7**
Tier 2	Phase 1	THC	0.257	0.269	0.212	0.269	0.251
		CO	1.119	1.414	0.997	1.464	1.295
		NOx	0.150	0.136	0.147	0.136	0.134
	Phase 2	THC	0.0206	0.0198	0.0181	0.0191	0.0142
		CO	0.0058	0.0096	0.0027	0.0059	0.0064
		NOx	0.0117	0.0123	0.0228	0.0112	0.0147
NLEV	Phase 1	THC	0.448	0.435	0.410	0.433	0.441
		CO	2.488	2.809	2.214	2.819	2.714
		NOx	0.461	0.441	0.504	0.483	0.471
	Phase 2	THC	0.0350	0.0147	0.0218	0.0225	0.0232
		CO	0.4001	0.7345	0.0854	0.1303	0.1073
		NOx	0.0424	0.0354	0.0469	0.0584	0.0521

5.1.3 EPA-Auto Tier 2 Test Program

The EPA-Auto test program was a joint agency-industry study examining the impacts of fuel variation on exhaust emissions for nine Tier 2 vehicles.* The fuels and vehicle fleet are summarized in Tables 5-8 and 5-9, respectively. This study included evaluations of both sulfur and non-sulfur effects on exhaust emissions. Note that emission control equipment was laboratory-aged to simulate a service life of approximately 120,000 miles.

* This study is also called the "Mobile Source Air Toxics Study" (or MSAT Study) as it was executed to provide data to support the EPA's MSAT rulemaking. See Reference 77.

Table 5-8 EPA-Auto Tier 2 Test Program Fuels					
Parameter	**BASE**	**BASER**	**BASERB**	**BASERBS**	**CaRFG**
Ethanol, vol%	0	0	0	0	0
RVP, PSI	6.93	9.08	9.01	9.05	6.95
T50, °F	223.5	221	219.6	220.6	210
T90, °F	324	324.5	324.1	324	305.3
Aromatics, vol%	31.4	28.5	28.1	28.1	21.2
Sulfur, ppm	6	6	6	32	5

Table 5-9 EPA-Auto Tier 2 Test Program Vehicle Fleet		
Vehicle ID	**Model Year**	**Tier 2 Bin**
1	2006	5
2	2005	5
3	2004	5
4	2005	8
5	2005	5
6	2005	5
7	2004	8
8	2005	8
9	2005	5

The emissions data associated with the BASERB fuel were not used in this analysis of the non-sulfur fuel effects in MOVES because benzene content was the only primary property that changed (versus BASER) and benzene is not a gasoline parameter under evaluation in this project.

There were two fuel pairs used for the non-sulfur effects: BASE to BASER (RVP change), and BASE to CaRFG (distillation points and aromatics change). There was a single fuel pair—BASERB to BASERBS—used to evaluate the change in gasoline sulfur content from 6 to 32 ppm.

A summary of the calculated test fleet mean emission rates is presented in Table 5-10.

Table 5-10 EPA-Auto Tier 2 Program Test Fleet Mean Emission Rates (g/mi) by Fuel						
Exhaust Phase	**Pollutant**	**BASE**	**BASER**	**BASERB**	**BASERBS**	**CaRFG**
Phase 1	THC	0.254	0.232	N/A	N/A	0.194
	CO	1.861	1.913	N/A	N/A	2.148
	NOx	0.113	0.113	N/A	N/A	0.111
Phase 2	THC	0.0064	0.0089	0.0082	0.0141	0.0066
	CO	0.1425	0.1679	0.1569	0.1936	0.1351
	NOx	0.0062	0.0093	0.0094	0.0173	0.0082
Phase 1 minus Phase 3	THC	N/A	N/A	0.201	0.212	N/A
	CO	N/A	N/A	1.456	1.535	N/A
	NOx	N/A	N/A	0.090	0.108	N/A
N/A = not applicable to the analysis.						

5.1.4 API Sulfur Reversibility Study

The API Sulfur Reversibility Study examined the effects of reversing gasoline sulfur content on the exhaust emissions of six Tier 2 vehicles. The fuels consisted of a 9 ppm sulfur simulated California LEV III certification gasoline and that same fuel doped to a sulfur content of 80 ppm. The vehicle fleet is summarized in Table 5-11. Note that new catalytic convertors and sensors were procured and aged on an engine stand to the equivalent of 120,000 to 150,000 miles. The aged catalysts and sensors were then installed on six vehicles prior to emissions testing.

The test program consisted of initial testing on 9 ppm sulfur gasoline, followed by 80 ppm sulfur and finally a second round of 9 ppm sulfur (to test reversibility). The analysis used only the initial 9 ppm sulfur testing and excluded the second round of 9 ppm sulfur testing to avoid any consequences of non-reversibility.

The study report noted the unique test results for the Ford Focus.[78] A second round of testing was completed only for the Focus, which then exhibited differing results from the first round. For the analyses herein, two versions were completed—with and without the Ford Focus data (i.e., both rounds of data); the results were not appreciably different for the two versions. This document reports the results of the analysis including both rounds of testing of the Ford Focus.

There was a single fuel pair evaluated, 9 ppm and 80 ppm sulfur gasolines.

Table 5-11 API Reversibility Study Vehicle Fleet				
Control Number	**Model Year**	**Make and Model**	**Engine**	**Equipment on Emissions Label**
API01	2009	Chevrolet Malibu	2.4L I4	SFI, HO2S, TWC, AIR
API02	2012	Honda Civic EX	1.8L I4	TWC, AF SENSOR, HO2S, EGR, SFI
API03	2012	Hyundai Sonata	2.4L I4	DFI, HO2S(2), WU-TWC, TWC
API04	2012	Ford Focus	2.0L I4	TWC, H2OS, DGI, HAFS
API05	2012	Audi A3	2.0L I4 Turbo	DFI, TWC(2), HO2S(3), Air, CAC, TC, DOR
API06	2012	Toyota Camry	3.5L V6	SFI, 2A/FS, 2WU-TWC, 2HO2S, TWC

Table 5-12 summarizes the calculated test fleet mean emission rates.

Table 5-12 API Sulfur Reversibility Test Fleet Mean Emission Rates (g/mi) by Fuel			
Exhaust Phase	**Pollutant**	**9 ppm S**	**80 ppm S**
Phase 2	THC	0.0020	0.0035
	CO	0.0145	0.0066
	NOX	0.0046	0.0050
Phase 1 minus Phase 3	THC	0.0435	0.0441
	CO	0.6395	0.5541
	NOx	0.0152	0.0134

5.2 Non-Sulfur Modeling Results

The analysis of MOVES non-sulfur modeling presents the combined results of the CRC E-98 Project and EPA-Auto Tier 2 Test Program first, followed by the CRC E-74b Project results. The exhaust test data from the CRC E-98 Project and EPA-Auto Tier 2 Test Program were used to assess the MOVES2014 method. For comparative purposes, this portion of the MOVES fuel effect review also includes the alternate fuel correction regression equations referred to herein as Gunst 17-term, Gunst 16-term, Gunst Reduced, and EPA 16-term models. The objective was to determine if the use of those alternates improved the ability to model the effects of changes in non-sulfur fuel parameters on exhaust emissions.

CRC E-98 and EPA-Auto Tier 2 each included two fuel pairs used in the analysis. The results—defined as a percent change in exhaust emissions from the predictive models versus the study data—are shown graphically in the figures listed below. Each figure presents the results for both fuel pairs by study, by exhaust pollutant, and by start (Phase 1) and running (Phase 2) exhaust.

- Figure 5-1 – CRC E-98, THC Phase 1 Exhaust
- Figure 5-2 – CRC E-98, THC Phase 2 Exhaust
- Figure 5-3 – CRC E-98, NOx Phase 1 Exhaust
- Figure 5-4 – CRC E-98, NOx Phase 2 Exhaust
- Figure 5-5 – CRC E-98, CO Phase 1 Exhaust
- Figure 5-6 – CRC E-98, CO Phase 2 Exhaust
- Figure 5-7 – CRC E-98, PM Phase 1 Exhaust
- Figure 5-8 – CRC E-98, PM Phase 2 Exhaust
- Figure 5-9 – EPA-Auto Tier 2, THC Phase 1 Exhaust
- Figure 5-10 – EPA-Auto Tier 2, THC Phase 2 Exhaust
- Figure 5-11 – EPA-Auto Tier 2, NOx Phase 1 Exhaust
- Figure 5-12 – EPA-Auto Tier 2, NOx Phase 2 Exhaust
- Figure 5-13 – EPA-Auto Tier 2, CO Phase 1 Exhaust
- Figure 5-14 – EPA-Auto Tier 2, CO Phase 2 Exhaust

The mean absolute error (MAE) was used to provide a comparative statistical assessment across the four fuel comparisons from the combined CRC E-98 and EPA-Auto Tier 2 studies. Those results, representing the mean error in exhaust correction (study data versus predictive model), are presented in Table 5-13. Given the variation in error observed, the predictive accuracy of the individual models is quite similar and no individual predictive model consistently outperforms the others.

Table 5-13
Mean Absolute Error (MAE) of the Combined CRC E-98 and EPA-Auto Tier 2 Studies

Predictive Model	THC		NOx		CO		PM	
	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Gunst 17-term	5.8%	27.5%	6.2%	25.8%	11.4%	12.5%	14.6%	32.4%
Gunst 16-term	6.7%	27.8%	6.7%	25.4%	11.0%	12.8%	4.1%	17.1%
Gunst Reduced	5.4%	28.0%	7.7%	26.9%	11.2%	14.8%	6.8%	7.7%
EPA 16-term	3.9%	39.6%	14.7%	26.9%	13.7%	15.5%	9.5%	14.2%
MOVES2014	5.9%	24.3%	13.8%	26.9%	15.8%	14.6%	2.4%	3.6%

Note: PM results represent the MAE of two fuel pairs (E-98 only); THC, CO and NOx represent the MAE of four fuel pairs (E-98 and EPA-Auto Tier 2 combined).

Figure 5-1
Fuel Impact Comparison, CRC E-98 Test Program
Phase 1 THC

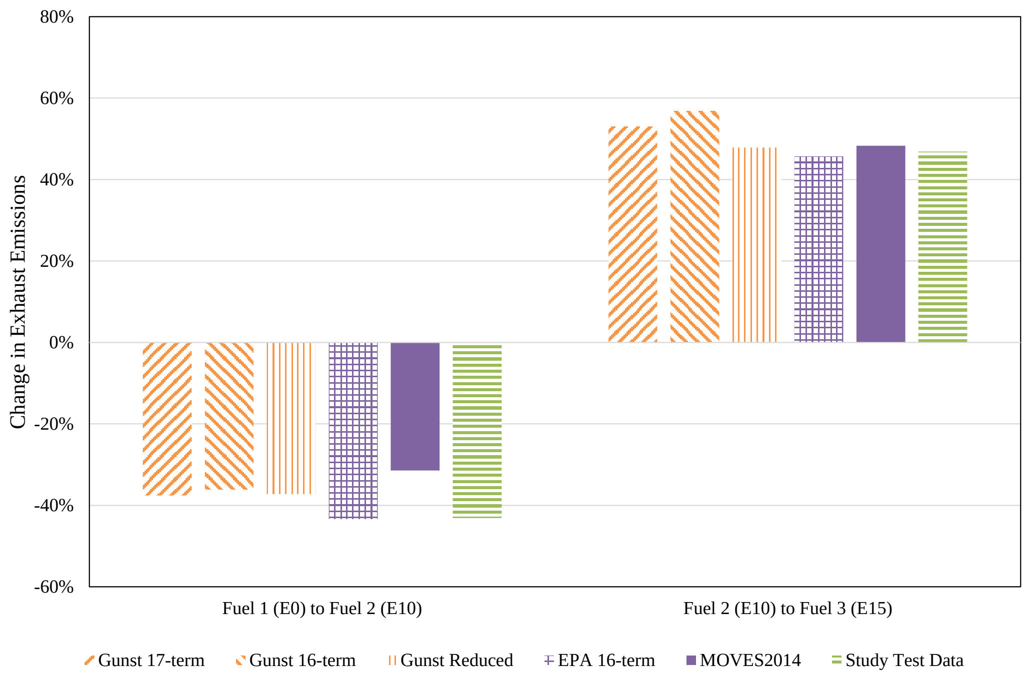


Figure 5-2
Fuel Impact Comparison, CRC E-98 Test Program
Phase 2 THC

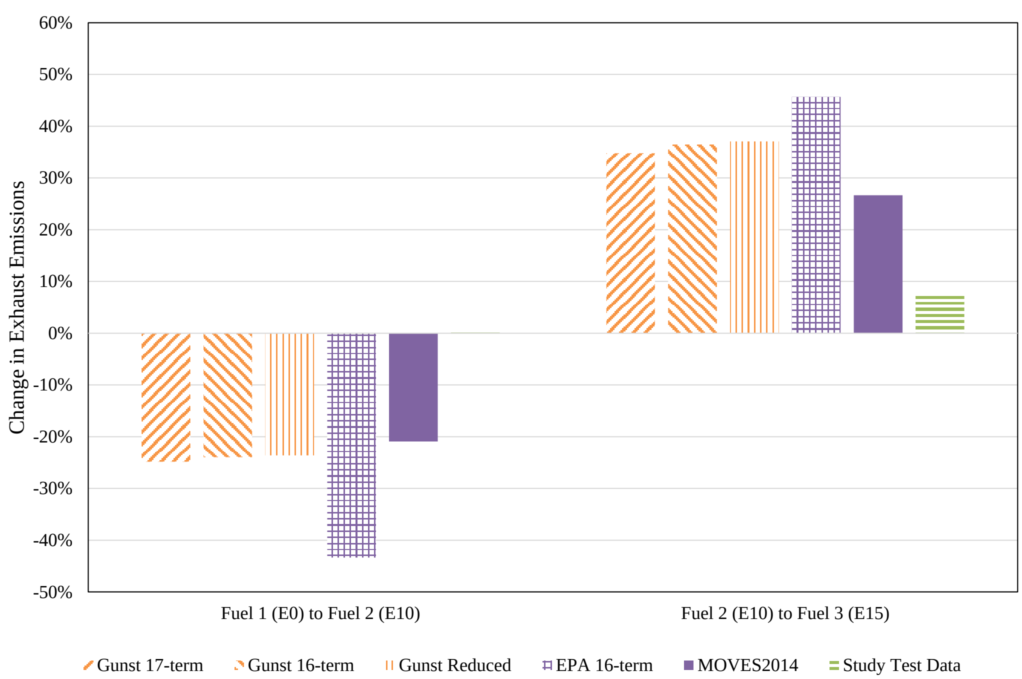


Figure 5-3
Fuel Impact Comparison, CRC E-98 Test Program
Phase 1 NOx

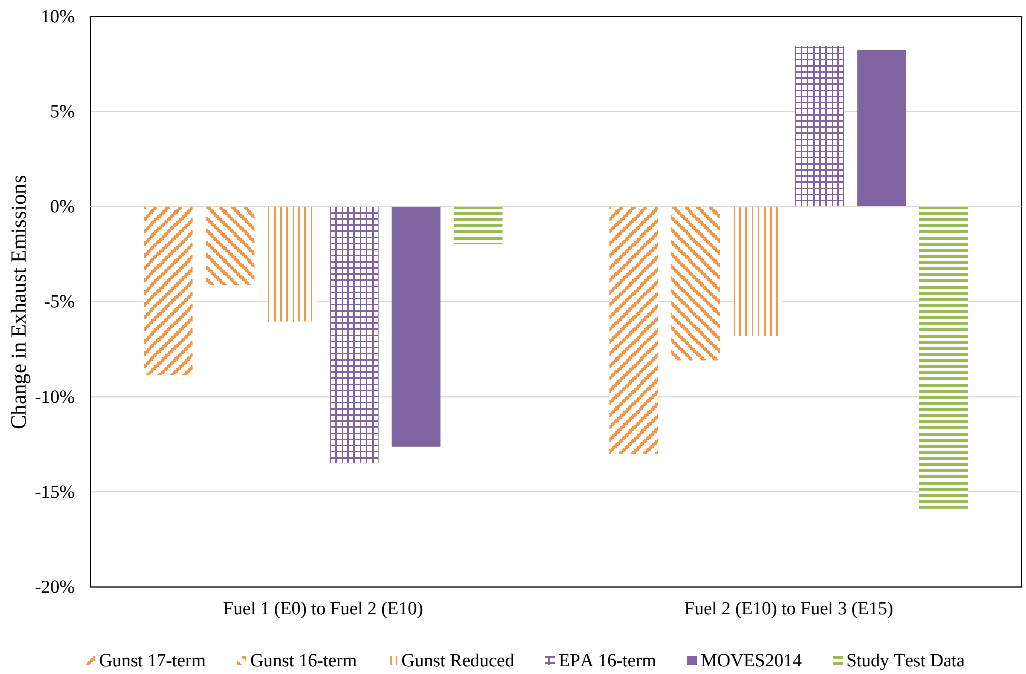


Figure 5-4
Fuel Impact Comparison, CRC E-98 Test Program
Phase 2 NOx

Figure 5-5
Fuel Impact Comparison, CRC E-98 Test Program
Phase 1 CO

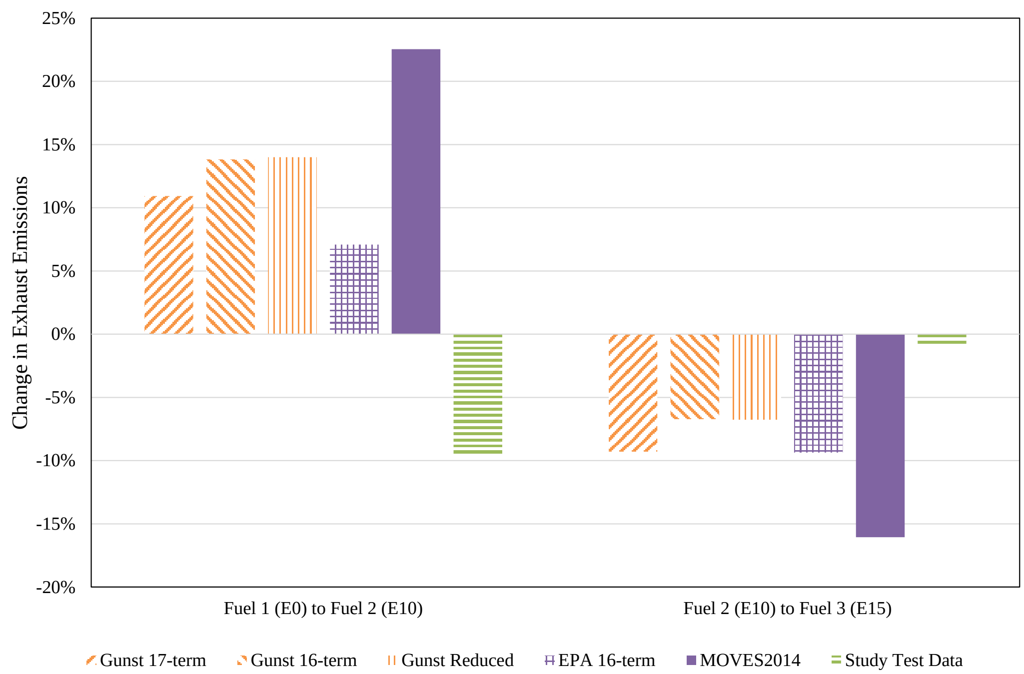


Figure 5-6
Fuel Impact Comparison, CRC E-98 Test Program
Phase 2 CO

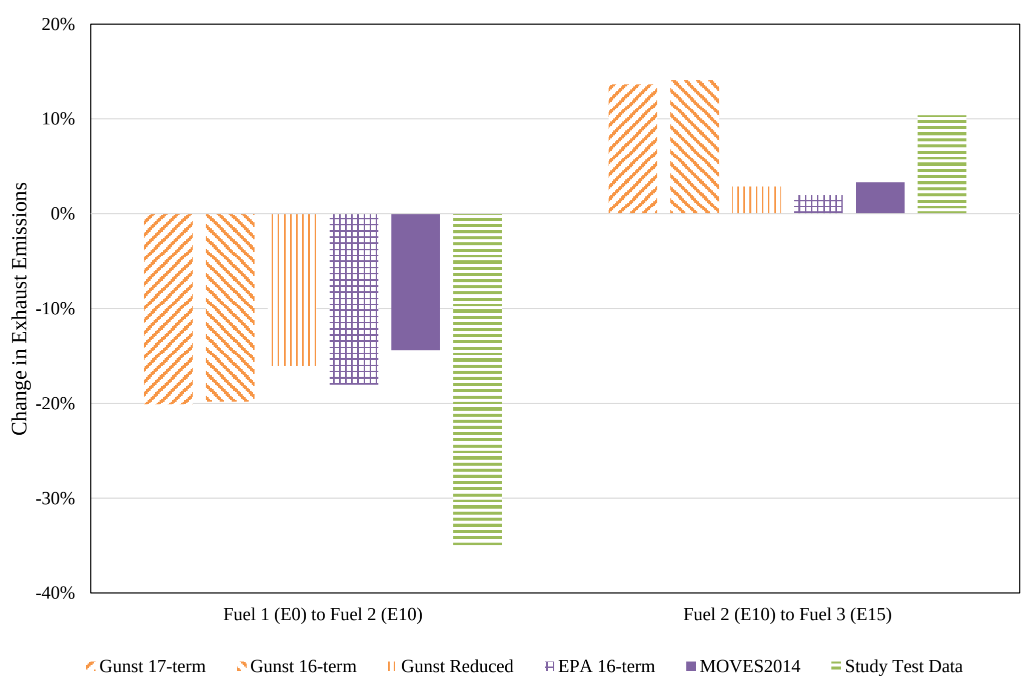


Figure 5-7
Fuel Impact Comparison, CRC E-98 Test Program
Phase 1 PM

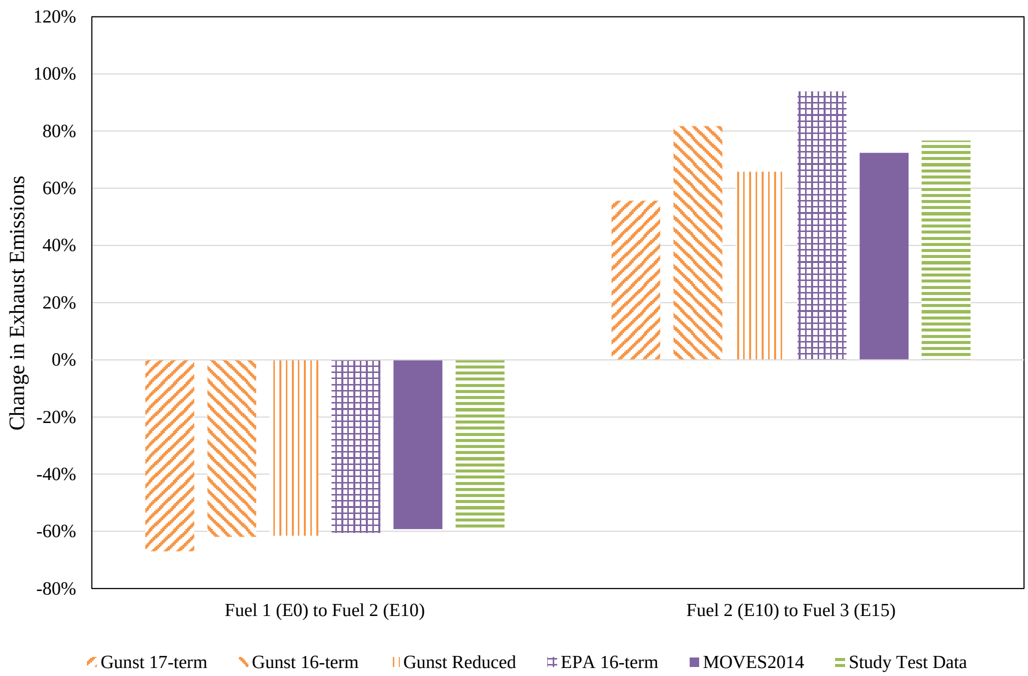


Figure 5-8
Fuel Impact Comparison, CRC E-98 Test Program
Phase 2 PM

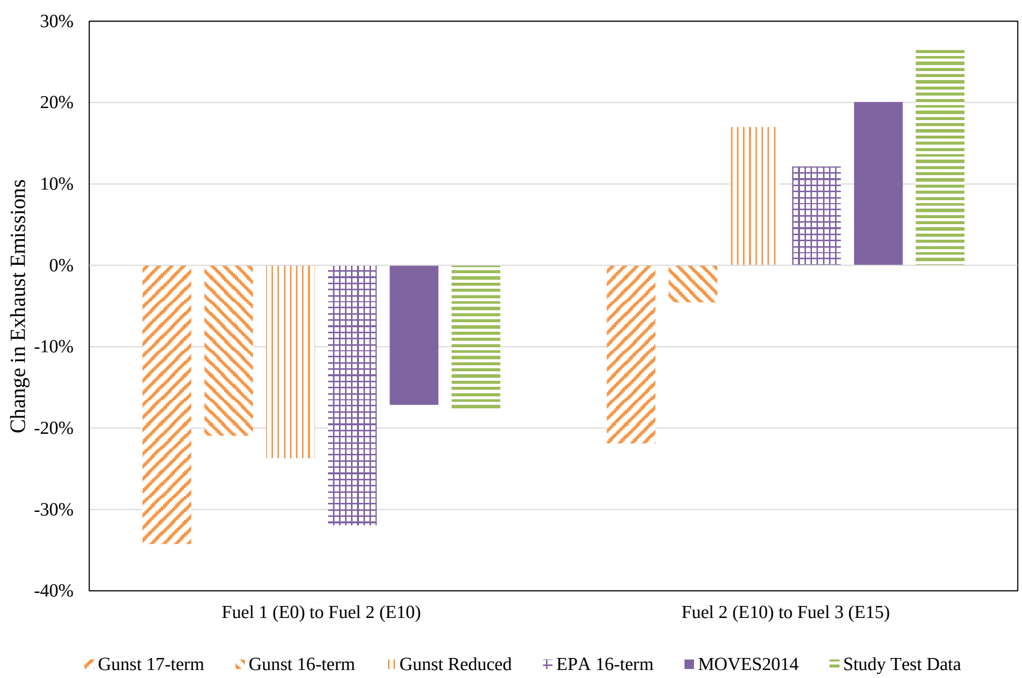


Figure 5-9
Fuel Impact Comparison, EPA-Auto Tier 2 Test Program
Phase 1 THC

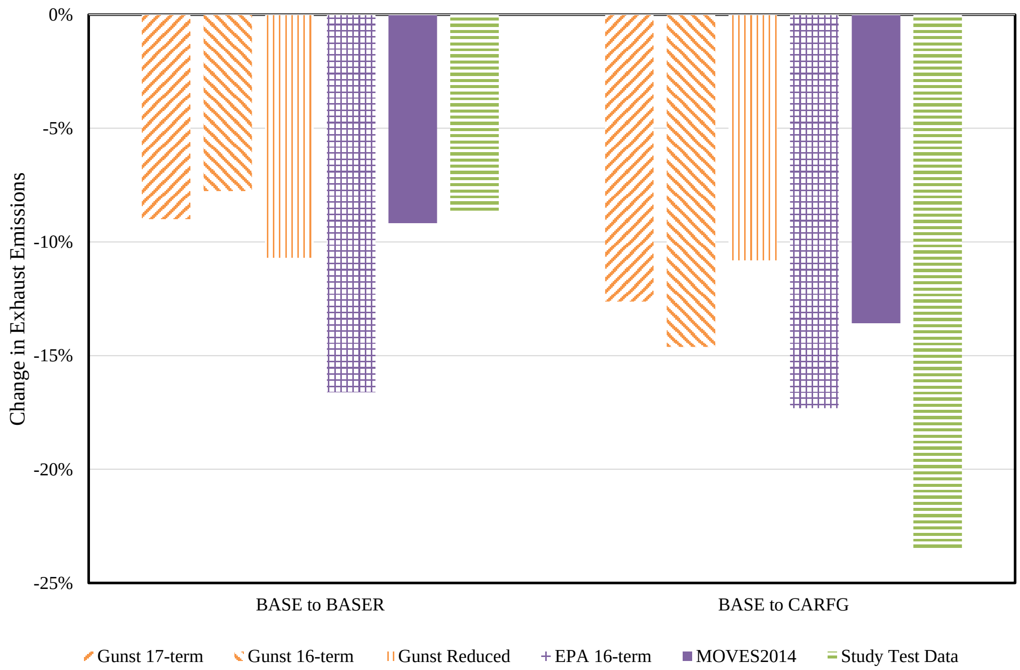


Figure 5-10
Fuel Impact Comparison, EPA-Auto Tier 2 Test Program
Phase 2 THC

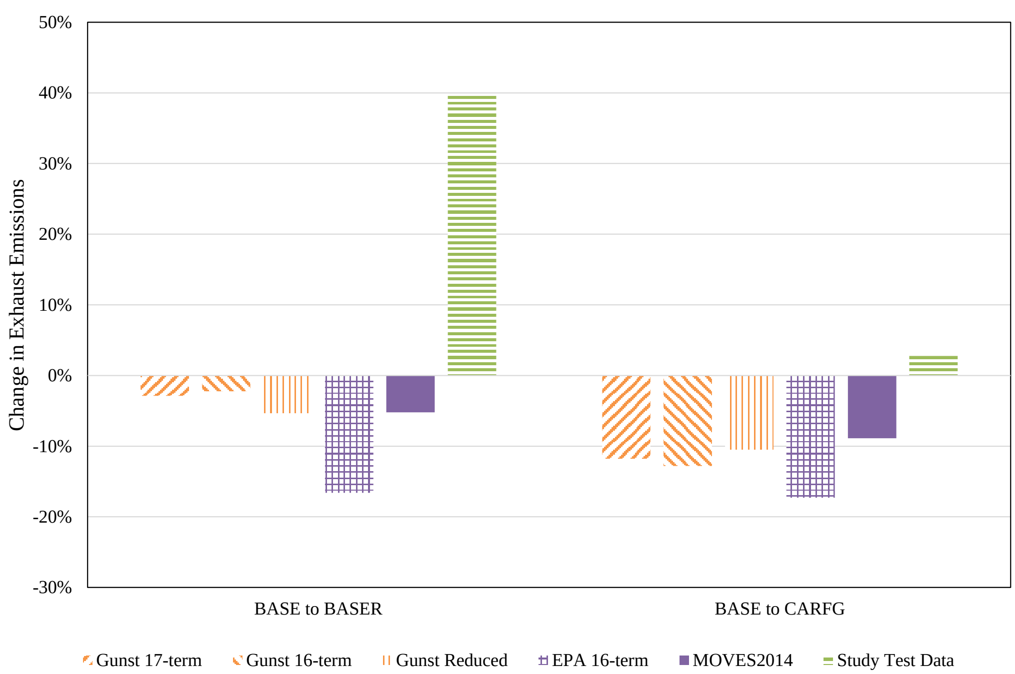


Figure 5-11
Fuel Impact Comparison, EPA-Auto Tier 2 Test Program
Phase 1 NOx

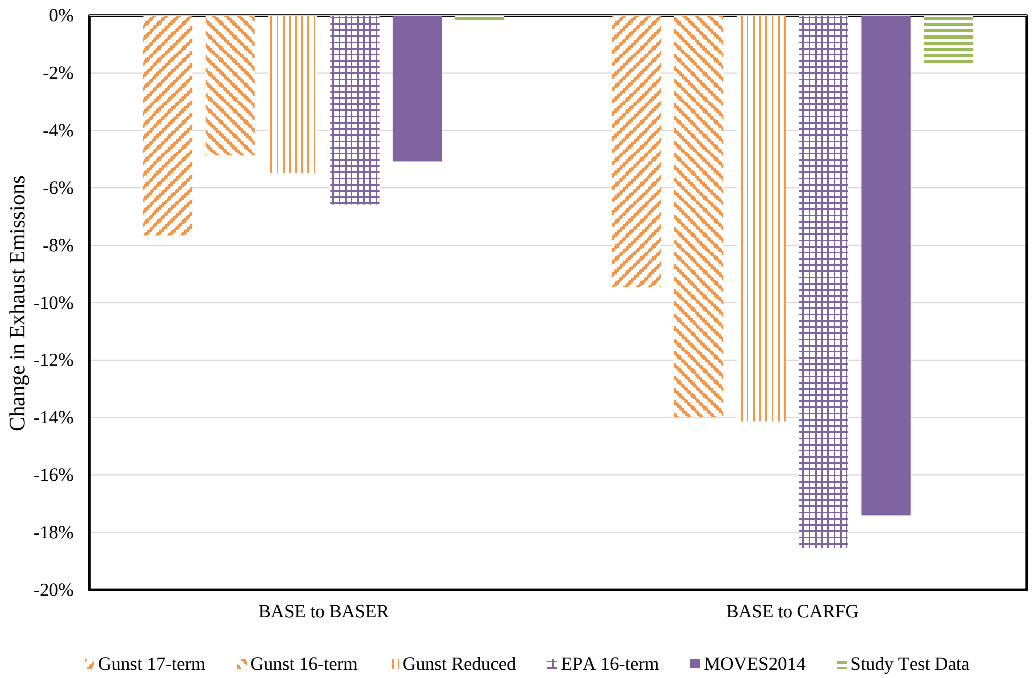


Figure 5-12
Fuel Impact Comparison, EPA-Auto Tier 2 Test Program
Phase 2 NOx

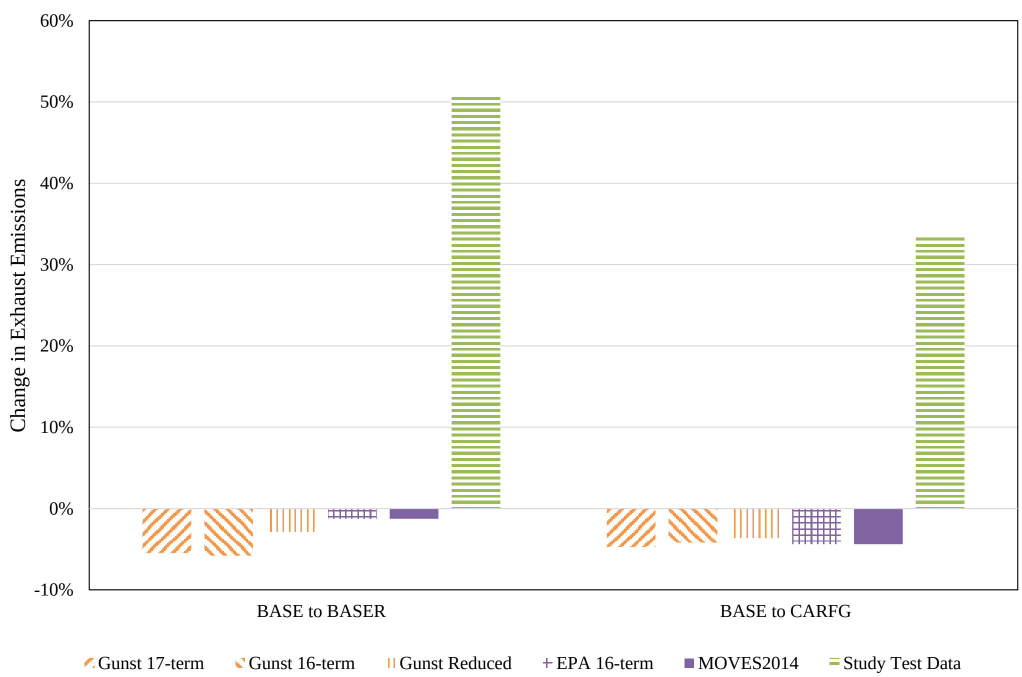


Figure 5-13
Fuel Impact Comparison, EPA-Auto Tier 2 Test Program
Phase 1 CO

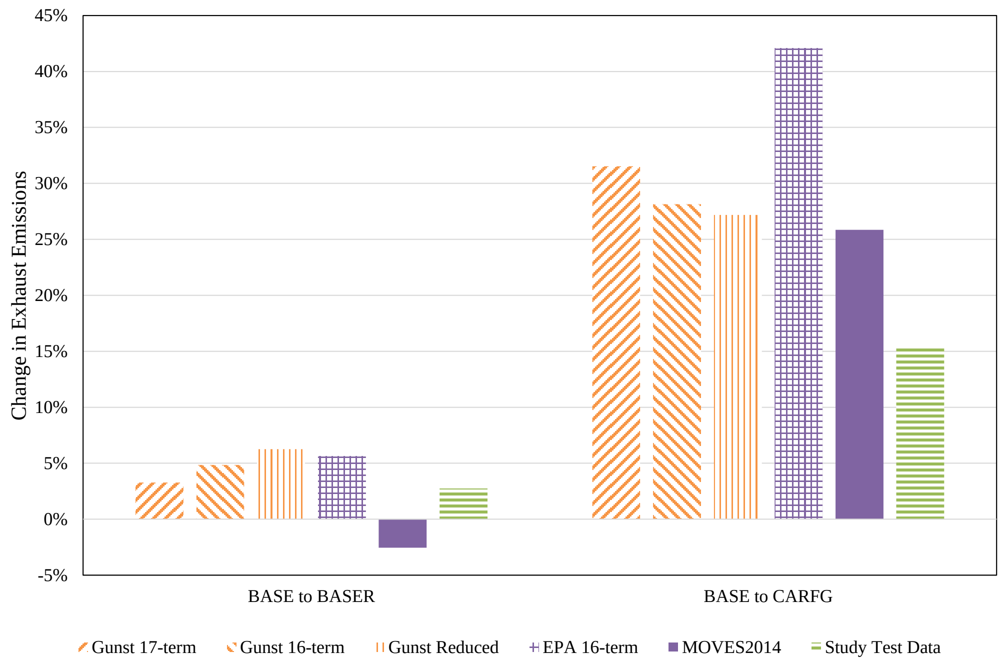


Figure 5-14
Fuel Impact Comparison, EPA-Auto Tier 2 Test Program
Phase 2 CO

The MOVES2014 comparative analysis using CRC E-74b included five fuel pairs. The results—defined as a percent change in exhaust emissions for the model versus the study data—are shown graphically a series of figures, as listed below. The comparison of the NLEV and Tier 2 study data was evaluated separately to determine the model's accuracy for both exhaust standards individually. Each figure presents the results for the five fuel pairs by exhaust pollutant, and by start (Phase 1) and running (Phase 2) exhaust.

- Figure 5-15 – CRC E-74b, THC Phase 1 Exhaust
- Figure 5-16 – CRC E-74b, THC Phase 2 Exhaust
- Figure 5-17 – CRC E-74b, NOx Phase 1 Exhaust
- Figure 5-18 – CRC E-74b, NOx Phase 2 Exhaust
- Figure 5-19 – CRC E-74b, CO Phase 1 Exhaust
- Figure 5-20 – CRC E-74b, CO Phase 2 Exhaust

The MAE was used to provide a comparative statistical assessment of the MOVES2014 method to predict the exhaust impacts on the NLEV and Tier 2 test fleets. Those results, representing the mean error in exhaust correction (study data vs. MOVES2014 prediction), are presented in Table 5-14. The MOVES2014 method is similarly accurate for the two certification-differentiated fleets, with the possible exception of Phase 2 THC and Phase 2 CO where the predictive accuracy for fuel effects of NLEVs was less.

Table 5-14
Mean Absolute Error (MAE) of the CRC E-74b Study Comparison

	THC		NOx		CO	
Exhaust Standard	**Phase 1**	**Phase 2**	**Phase 1**	**Phase 2**	**Phase 1**	**Phase 2**
NLEV	7.95%	51.91%	7.47%	24.49%	10.55%	57.47%
Tier 2	8.70%	17.98%	6.71%	31.15%	8.38%	27.53%

Note: Results represent the MAE of five fuel pairs.

Figure 5-15
Fuel Impact Comparison, CRC E-74 Test Program
Phase 1 Exhaust THC

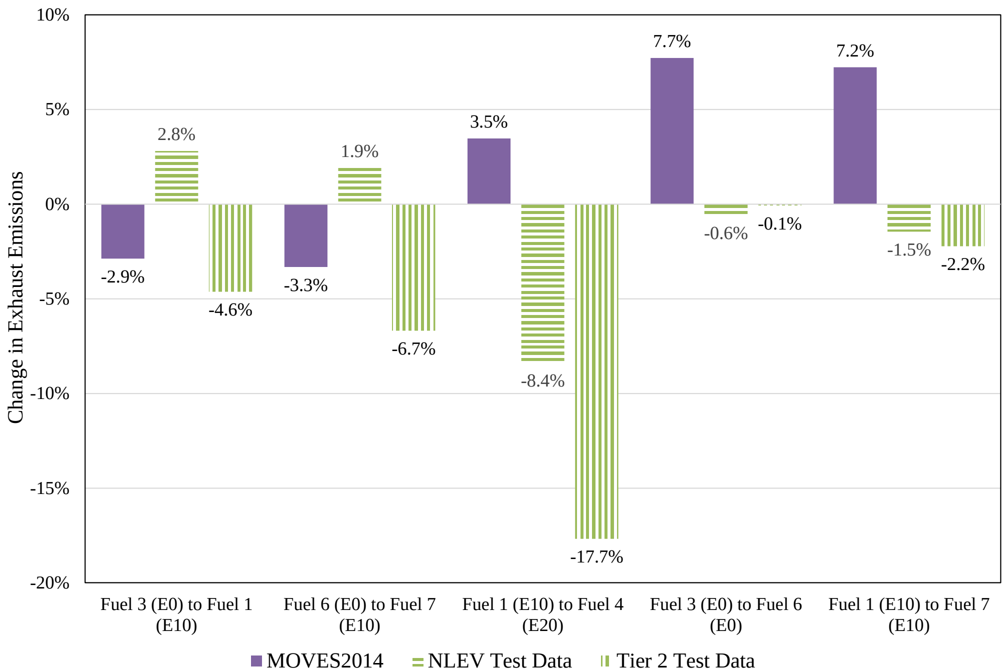


Figure 5-16
Fuel Impact Comparison, CRC E-74 Test Program
Phase 2 Exhaust THC

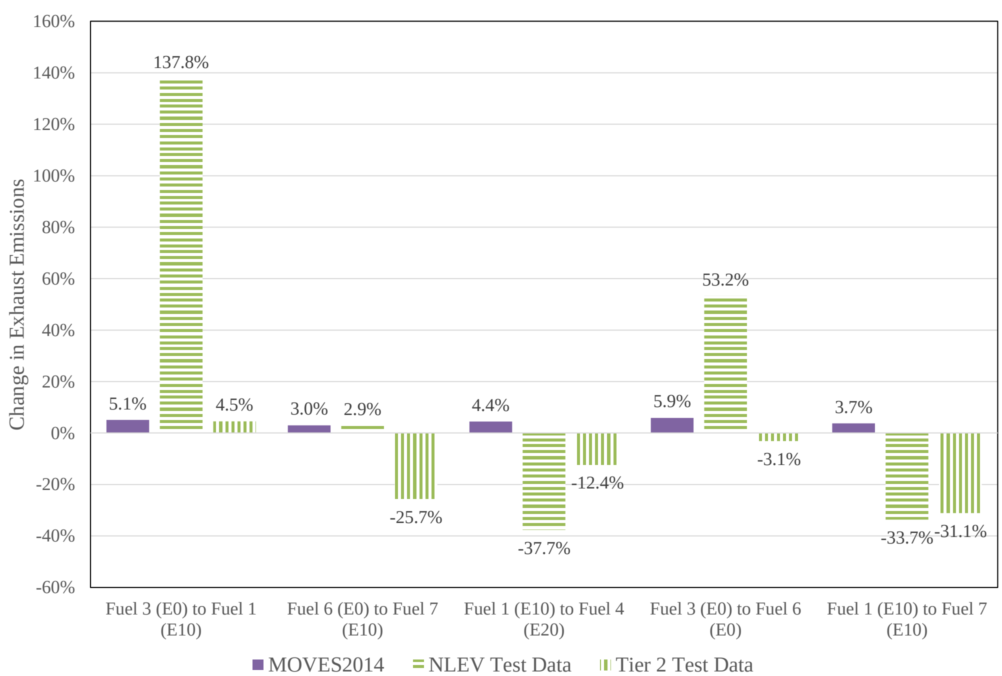


Figure 5-17
Fuel Impact Comparison, CRC E-74 Test Program
Phase 1 Exhaust NOx

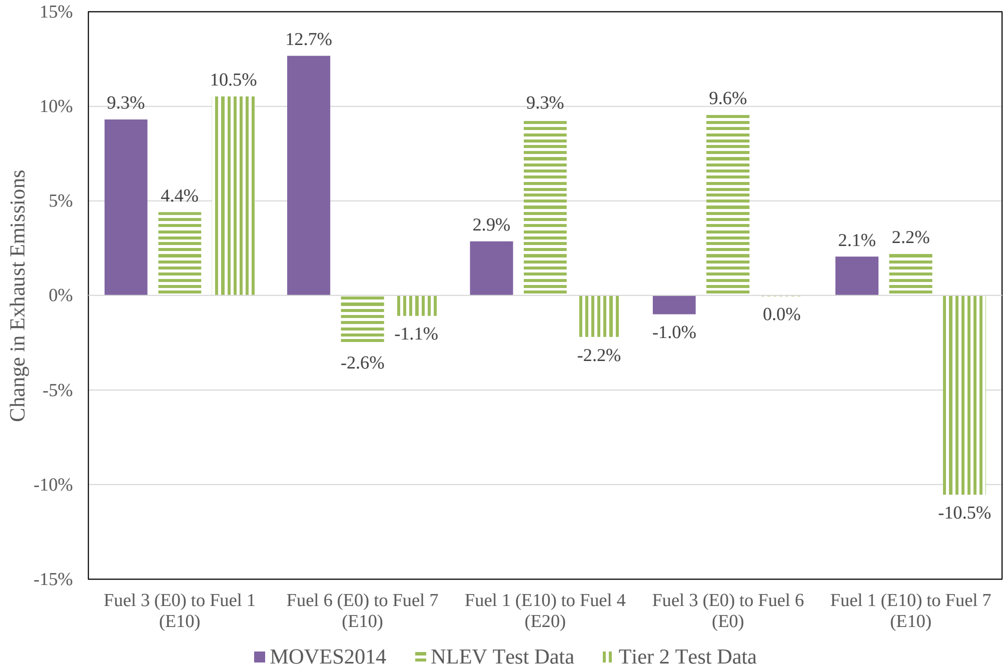


Figure 5-18
Fuel Impact Comparison, CRC E-74 Test Program
Phase 2 Exhaust NOx

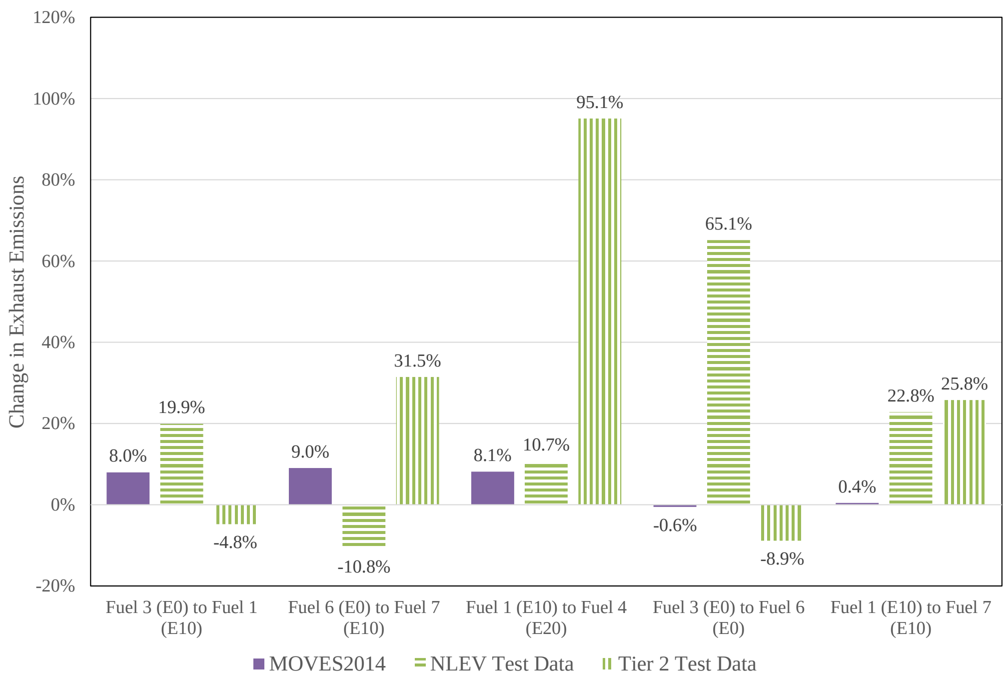


Figure 5-19
Fuel Impact Comparison, CRC E-74 Test Program
Phase 1 Exhaust CO

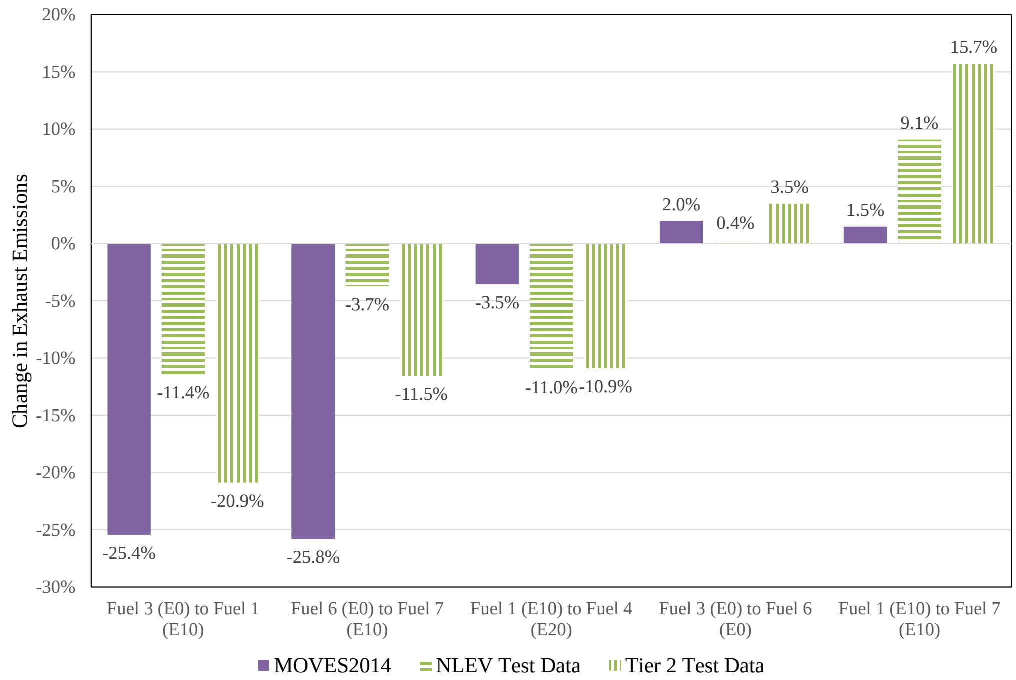
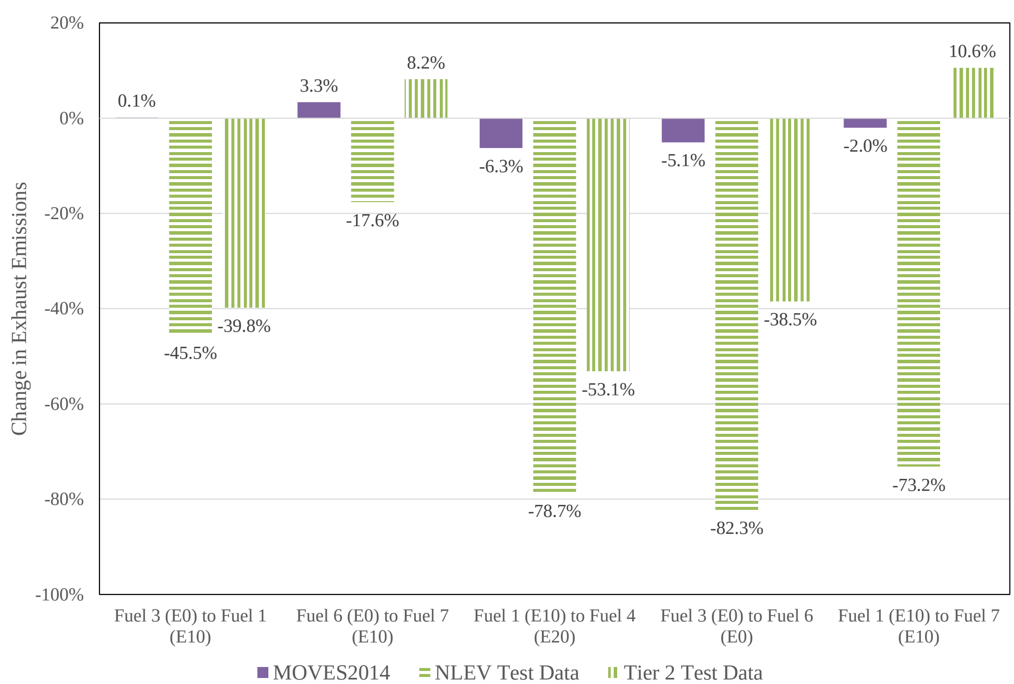


Figure 5-20
Fuel Impact Comparison, CRC E-74 Test Program
Phase 2 Exhaust CO



5.3 Sulfur Modeling Results

The exhaust test data from the API Sulfur Reversibility Study and the EPA-Auto Tier 2 Test Program were used to assess the MOVES2014 method for gasoline sulfur corrections applied to 2001 and later model year vehicles. A low-sulfur gasoline and a high-sulfur gasoline were tested in each study, and the relative impact on exhaust emissions from increased sulfur content was calculated for the fleet average and compared against the model prediction. The theory is that sulfur poisons the catalyst, and thus increasing the sulfur content will reduce catalyst efficiency and increase exhaust emissions.

Figure 5-21 presents the results for the 9 to 80 ppm sulfur change examined in the API Sulfur Reversibility Study. Figure 5-22 presents the results for the 6 to 32 ppm sulfur change examined in the EPA-Auto Tier 2 program. On one hand, the EPA-Auto study measured increases in exhaust emissions, from increased sulfur content, exceeding the model's predictions in all but one case (the lone exception being THC start exhaust). The API study, on the other hand, measured emissions impacts that were less than the model predictions for all but one case (the lone exception being THC running exhaust).[*] In this way, it can be generalized that the model's predicted sulfur impacts fell between the results of the two independent studies.

It is also relevant to note that the three testing protocols (that underlying the MOVES2014 method and those of the two studies) all differed, and there is no standardized approach to estimating the impact of sulfur content changes on exhaust emissions. Each of the three protocols used distinct sulfur clean-out procedures, and each used significantly different sulfur loading procedures (both in terms of duty cycle and mileage driven). The degree to which these protocol differences impacted the analyses reported here is not clear.

[*] Indeed, Figure 5-22 illustrates that increasing sulfur reduced exhaust in some cases in the vehicle fleet. Whereas the API study measured increased exhaust for the higher sulfur gasoline for the FTP composite and Phase 3 of the FTP for all pollutants; the running exhaust (Phase 2 of the FTP) and start exhaust (defined here as Phase 1 minus Phase 3 of the FTP) produced directionally variable impacts as shown.

Figure 5-21
Fuel Impact Comparison, API Sulfur Reversibility Study
Change from 9 to 80 ppm S

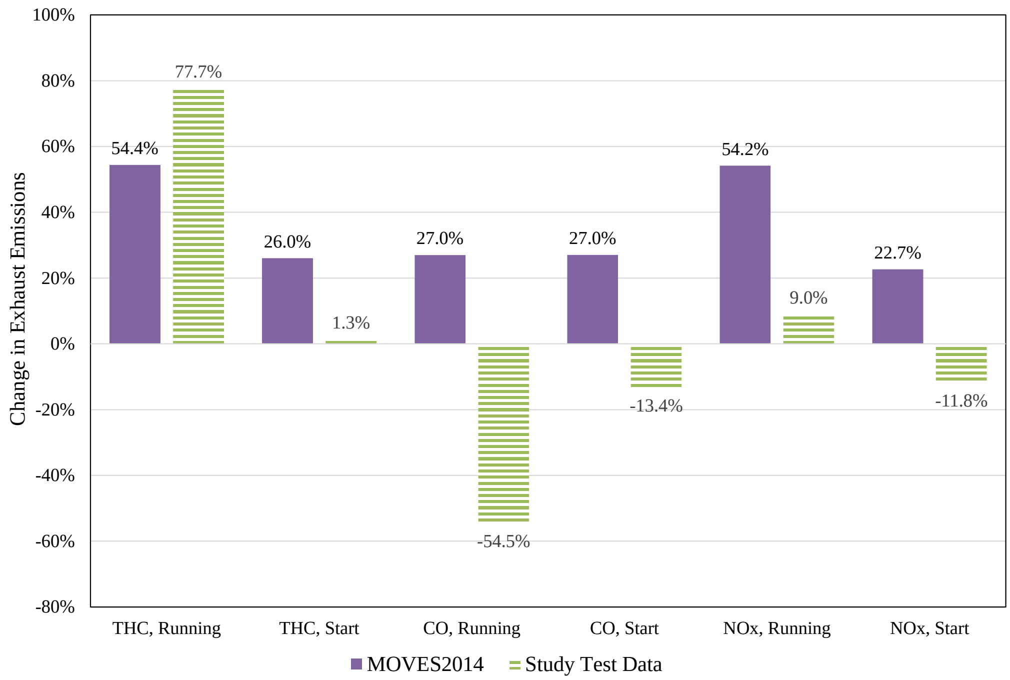
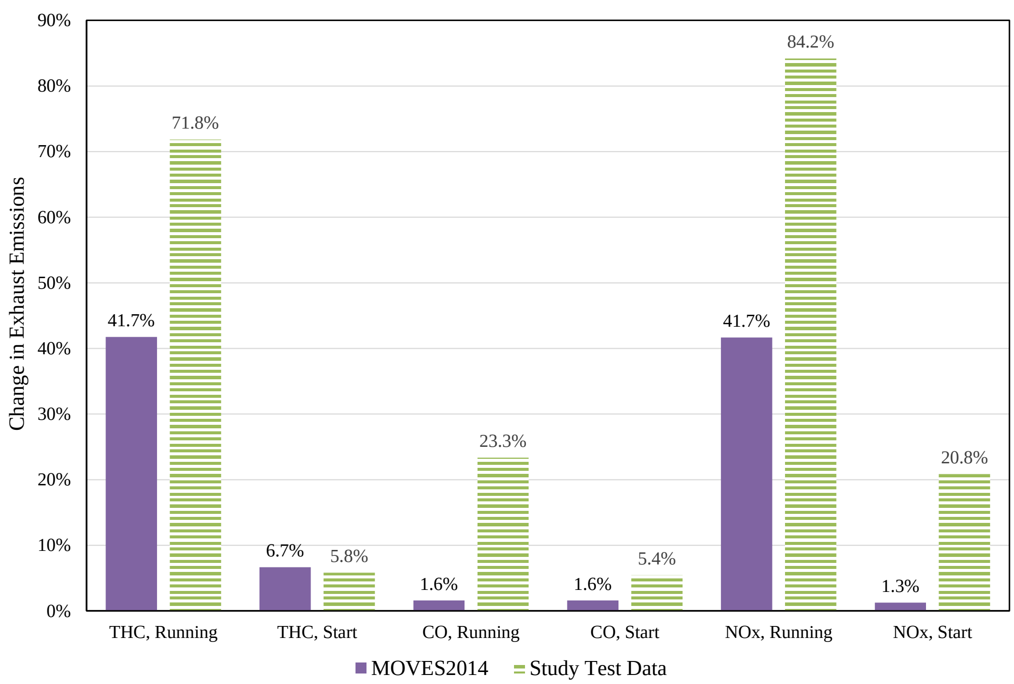


Figure 5-22
Fuel Impact Comparison, EPA-Auto Tier 2 Study
Change from 6 to 32 ppm S



5.4 Final Remarks

The results of the analyses conducted provide information related to the uncertainty of the MOVES2014 fuel correction methods that may be useful in evaluating the factors influencing vehicle emissions.

The selected studies represent the best available data for evaluating the MOVES2014 correction methods. However, they encompass a finite set of fuel pairs and the results reported herein cannot be considered comprehensive. Moreover, additional consideration should be given to the fact that some of the test fuels (e.g., E20) are not commercially marketed fuels and that testing on these higher ethanol blends was completed with test vehicles not necessarily designed to operate on such fuels.[*]

The results of this assessment show generally that the form of the MOVES2014 non-sulfur correction equation performed equally well as other predictive models found in the literature.

It is difficult to draw conclusions concerning the MOVES2014 sulfur methods due to the absence of consistent test protocols employed by the two studies used to comparatively assess the model estimates.

###

[*] Some test fleets included FFVs engineered to operate on a range of ethanol content (up to 85 percent by volume); otherwise, EPA has issued a waiver allowing only 2001 and later model year light-duty gasoline vehicles the option to use fuel containing a maximum allowable ethanol content of 15 volume percent.

6. REFERENCES

1. 79 FR 60343.

2. 76 FR 57106.

3. *www3.epa.gov/otaq/models/moves/documents/faca-meeting-sep2012/04-hd-ghg-rule-impl-moves.pdf*

4. *www3.epa.gov/otaq/models/moves/documents/faca-meeting-sep2012/02-hd-emission-vehicle-test-programs.pdf*

5. "Development of Emission Rates for Heavy-Duty Vehicles in the Motor Vehicle Emissions Simulator MOVES2010, Final Report," EPA-420-B-12-049, U.S. Environmental Protection Agency, August 2012.

6. "Exhaust Emission Rates for Heavy-Duty On-road Vehicles in MOVES2014," EPA-420-R-15-015, U.S. Environmental Protection Agency, September 2015.

7. "In-Use Emissions Testing and Demonstration of Retrofit Technology for Control of On-Road Heavy-Duty Engines," prepared by Center for Alternative Fuels, Engines, & Emissions, West Virginia University; prepared for South Coast Air Quality Management District, July 2014.

8. "EMFAC2014 Volume III – Technical Documentation, v1.0.7," California Air Resources Board, May 12, 2015.

9. Meeting: Public Workshop on Updates to Mobile Source Emission Inventory Tool, California Air Resources Board, October 8, 2013. Presentations material available at *www.arb.ca.gov/msei/msab_oct_workshop_10_07_2013_final.pdf*.

10. Jääskeläinen, H. "Crankcase Ventilation." DieselNet Technology Guide. *www.DieselNet.com*. Copyright © Ecopoint Inc. Revision 2012.12.

11. Ireson, R.G., Ondov, J. M., Zielinska, B.,. Weaver, C. S., Easter, M. D., Lawson, D. R., Hesterberg, T. W., Davey, M. E., Liu, L.-J. S. "Measuring In-Cabin School Bus Tailpipe and Crankcase PM2.5: A New Dual Tracer Method," Journal of the Air & Waste Management Association, 2011, 61:5, 494-503.

12. Tatli, E. and Clark, N., "Crankcase Particulate Emissions from Diesel Engines," SAE Int. J. Fuels Lubr. 1(1):1334-1344, 2009, doi:10.4271/2008-01-1751.

13. 79 FR 23414.

14. "Developing Emission Rates Representing the Effect of Proposed Tier-3 Standards on Gaseous Emissions from Gasoline-Powered Light-duty Vehicles (HC/CO/NOx)," Memorandum from James Warila (U.S. Environmental Protection Agency, Office of Transportation and Air Quality) to Docket EPA-HQ-OAR-2011-0135, December 2011.

15. "Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards, Summary and Analysis of Comments," EPA-420-R-14-004, U.S. Environmental Protection Agency, March 2014.

16. "Development of Emission Rates for Light-Duty Vehicles in the Motor Vehicle Emissions Simulator (MOVES2010), Final Report," EPA-420-R-11-011, U.S. Environmental Protection Agency, August 2011.

17. "Exhaust Emission Rates for Light-Duty On-road Vehicles in MOVES2014," EPA-420-R-15-005, U.S. Environmental Protection Agency, October 2015.

18. "Kansas City PM Characterization Study, Final Report," EPA420-R-08-009, prepared by Eastern Research Group for the U.S. Environmental Protection Agency, April 2008.

19. "Regulatory Impact Analysis, Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards, Final Rule," EPA420-R-14-005, U.S. Environmental Protection Agency, February 2014.

20. "Determination and Evaluation of New Prep Cycle on the Fuel Effects of Gaseous Emissions on SIDI In-Use Vehicles," CRC Project E-94-1a, December 2014.

21. "Evaporative Emissions from On-Road Vehicles in MOVES2014," EPA-420-R-14-014, U.S. Environmental Protection Agency, 2014. Available at *www3.epa.gov/otaq/models/moves/documents/420r14014.pdf*.

22. "The DELTA Model: Improved Evaporative Emissions Modeling for EPA MOVES," DRAFT, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, October 13, 2011.

23. "DELTA: A Multiple-day Cold Soak Emissions Calculator for MOVES," U.S. Environmental Protection Agency, 2013. Available at *www3.epa.gov/otaq/models/moves/documents/faca-meeting-jan2013/04-delta.pdf*

24. Personal communication from David Brzezinski (EPA) and Jeremy G. Heiken (Sierra Research), 2015.

25. U.S. Environmental Protection Agency, 2015. “Canister Degradation Study,” 25th CRC Real World Emissions Workshop, March 24, 2015.

26. Kota, Sri Harsha et al., 2014. “Estimation of VOC emission factors from flux measurements using a receptor model and footprint analysis.” Atmospheric Environment 82: 24-35.

27. Harold M. Haskew, Thomas F. Liberty, and Dennis McClement. “Fuel Permeation from Automotive Systems.” CRC E-65, September 2004.

28. “Fuel Permeation from Automotive Systems: E0, E6, E10 and E85, Interim Report,” CRC Project No. E-65-3, August 2006.

29. Harold M. Haskew and Thomas F. Liberty. “Vehicle Evaporative Emission Mechanisms: A Pilot Study,” CRC E-77, June 2008.

30. Harold M. Haskew and Thomas F. Liberty. “Enhanced Evaporative Emission Vehicles,” CRC E-77-2, March 2010.

31. Harold M. Haskew and Thomas F. Liberty. “Evaporative Emissions from In-use Vehicles: Test Fleet Expansion,” CRC E-77-2b, October 2010.

32. Harold M. Haskew and Thomas F. Liberty. “Study to Determine Evaporative Emission Breakdown, Including Permeation Effects and Diurnal Emissions Using E20 Fuels on Aging Enhanced Evaporative Emissions Certified Vehicles,” CRC E-77-2c, December 2010.

33. “Multi-Day Diurnal Testing,” Assessment and Standards Division, Office of Transportation and Air Quality, EPA-420-R-14-006, U.S. Environmental Protection Agency, March 2014.

34. “The Effects of Ultra-Low Sulfur Gasoline on Emissions from Tier 2 Vehicles in the In-Use Fleet, Final Report,” EPA-420-R-14-002, U.S. Environmental Protection Agency, March 2014.

35. “Assessing the Effect of Five Gasoline Properties on Exhaust Emissions from Light-Duty Vehicles Certified to Tier 2 Standards: Analysis of Data from EPAct Phase 3 (EPAct/V2/E-89) Final Report,” EPA-420-R-13-002, U.S. Environmental Protection Agency, April 2013.

36. “MOVES2010 Fuel Adjustment and Air Toxic Emission Calculation Algorithm – Development and Results,” EPA-420-R-11-009, U.S. Environmental Protection Agency, July 2011.

37. “Fuel Effects on Exhaust Emissions from On-road Vehicles in MOVES2014,” EPA-420-R-16-001, U.S. Environmental Protection Agency, February 2016.

38. Anderson, J., Wallington, T., Stein, R., and Studzinski, W., "Issues with T50 and T90 as Match Criteria for Ethanol-Gasoline Blends," SAE Int. J. Fuels Lubr. 7(3):1027-1040, 2014, doi:10.4271/2014-01-9080.

39. "Effects of Vapor Pressure, Oxygen Content and Temperature on CO Exhaust Emissions," CRC Report No. E-74b, May 2009.

40. "Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards, Summary and Analysis of Comments," EPA-420-R-14-004, U.S. Environmental Protection Agency, March 2014.

41. "Review of Prior Studies of Fuel Effects on Vehicle Emissions," CRC Project E-84, August 2008.

42. "Study of MOVES Information for the National Emission Inventory: CRC Project A-84," October 2013.

43. "MOVES Input Improvements for the 2011 NEI: CRC Project A-88," October 2014.

44. "Regional Fuels and the MOVES Default Fuel Supply," presentation by Jarrod Brown, U.S. EPA Office of Transportation and Air Quality, FACA Modeling Workgroup Meeting, April 30, 2013 *www3.epa.gov/otaq/models/moves/documents/faca-meeting-apr2013/08-fuel-supplies-brown.pdf*.

45. "Procedures for Using the California Model for California Reformulated Gasoline Blendstocks for Oxygenate Blending (CARBOB)," California Air Resources Board, August 7, 2008.

46. "Determination of the Potential Property Ranges of Mid-Level Ethanol Blends, Final Report," American Petroleum Institute, April 23, 2010.

47. "Population and Activity of On-road Vehicles in MOVES2014," EPA-420-R-16-003a, U.S. Environmental Protection Agency, March 2016.

48. "Updates to MOVES Vehicle Activity, U.S. Environmental Protection Agency, FACA MOVES Review Workgroup, July 2013.

49. "New York State MOBILE6 On-Road Motor Vehicle Emission Budget Technical Documentation," New York State Department of Environmental Conservation, May 2003.

50. Volume IV, Chapter 1, Preferred and Alternative Methods for Gathering and Locating Specific Emission Inventory Data (Methodology for Gathering Locality-Specific Emission Inventory Data), Emissions Inventory Improvement Program, U.S. Environmental Protection Agency, June 1996.

51. “MOVES2014 and MOVES2014a Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity,” EPA-420-B-15-093, U.S. Environmental Protection Agency, November 2015.

52. Current, on-going work for Environment Canada evaluating the proposed Phase 2 heavy-duty fuel efficiency rulemaking, Oak Leaf Environmental, 2016.

53. “Transportation Energy Data Book,” Edition 34, ORNL-6991, Oak Ridge National Laboratory, August 2015.

54. “Emission Adjustments for Temperature, Humidity, Air Conditioning, and Inspection and Maintenance for On-road Vehicles in MOVES2014,” EPA-420-R-14-012, U.S. Environmental Protection Agency, December 2014.

55. “Cold Temperature Measurement of Particulate and Gaseous Emissions from Tier 2 MSAT Vehicles,” U.S. Environmental Protection Agency, FACA MOVES Review Workgroup, July 2913.

56. “Speciation of Total Organic Gas and Particulate Matter Emissions from On-road Vehicles in MOVES2014,” EPA-420-R-14-020, U.S. Environmental Protection Agency, October 2014.

57. “Air Toxic Emissions from On-road Vehicles in MOVES2014,” EPA-420-R-14-021, U.S. Environmental Protection Agency, , December 2014.

58. “Mapping MOVES TOG to Chemical Mechanism Species for Air Quality Modeling,” U.S. Environmental Protection Agency, FACA MOVES Review Workgroup, July 2013.

59. “PM2.5 Speciation in MOVES2013,” U.S. Environmental Protection Agency, FACA MOVES Review Workgroup, July 2013.

60. “Modeling ‘Additional’ Air Toxics in MOVES,” U.S. Environmental Protection Agency, FACA MOVES Review Workgroup, July 2013.

61. “Ozone Modeling Predictions Sensitivity to Speciation of Exhaust VOC Emissions, CRC A-85,” May 2015.

62. Zielinska, B., et. al., 2008. “Detailed Characterization and Profiles of Crankcase and Diesel Particulate Matter Exhaust Using Speciated Organics,” Environmental Science and Technology, 42, 5661-56666.

63. “Review of MOVES2004,” Sierra Research Report No. SR2005-07-01, prepared for the Alliance of Automobile Manufacturers, July 11, 2005.

64. "Review of the 2009 Draft Motor Vehicle Emissions Simulator (MOVES) Model," CRC Project: E-68a, November 2010.

65. Version 2 NEI data files downloaded from EPA's FTP site: *ftp://ftp.epa.gov/EmisInventory/2011/doc/MOVES_CDBs_by_state/*, files date stamped December 2014, accessed April 2015.

66. "Georgia's Redesignation Request and Maintenance Plan for the Atlanta Ozone Nonattainment Area for the 1997 8-Hour Ozone NAAQS," Georgia Department of Natural Resources, March 21, 2012.

67. "Georgia's Redesignation Request and Maintenance Plan for the Atlanta Ozone Nonattainment Area for the 1997 PM2.5 NAAQS," Georgia Department of Natural Resources, August 16, 2012.

68. "2014 National Population Projections," United States Census, downloadable data from *www.census.gov/population/projections/data/national/2014.html*, date of access July 2015.

69. Maricopa County demographics data downloaded from *https://population.az.gov/population-projections*, date of access July 2015.

70. Personal e-mail communication from Joan Weidner (Southeast Michigan Council of Governments) and Jeremy G. Heiken (Sierra Research), June 3, 2015.

71. "EMFAC2014, Volume III – Technical Documentation, v1.0.7," California Air Resources Board, May 12, 2015.

72. "Demonstration of the Necessity of Regulations Requiring 7.0 PSI RVP Gasoline in Clark County, Nevada as an Ozone Control Strategy," prepared by Sierra Research for the Clark County Department of Air Quality and Environmental Management, November 9, 2007.

73. "Determination and Evaluation of new Prep Cycle on the Fuel Effects of Gaseous Emissions on SIDI In-use Vehicles," CRC Project E-94-1a, December 2014.

74. "Exhaust Emissions of Average Fuel Composition," CRC Report No. E-98/A-80, June 2014.

75. "Effects of Vapor Pressure, Oxygen Content and Temperature on CO Exhaust Emissions," CRC Report No. E-74b, May 2009.

76. Data and documentation provided by e-mail from Ed Nam (EPA) to Jeremy G. Heiken (Sierra Research) for use in this project, April 8, 2015.

77. “Control of Hazardous Air Pollutants from Mobile Sources, Regulatory Impact Analysis,” EPA420-R-07-002, U.S. Environmental Protection Agency, February 2007.

78. “Reversibility of Gasoline Sulfur Effects on Exhaust Emissions from Late Model Vehicles,” prepared by SGS Environmental Testing Corporation for the American Petroleum Institute, June 2013.

79. Gunst, R. F., “Statistical Analysis of the Phase 3 Emissions Data Collected in the EPAct/V2/E89 Program,” NREL/SR-5400-52484, May 2013.

80. “Assessing the Effect of Five Gasoline Properties on Exhaust Emissions from Light-Duty Vehicles Certified to Tier 2 Standards: Analysis of Data from EPAct Phase 3 (EPAct/V2/E-89) Final Report,” EPA-420-R-13-002, U.S. Environmental Protection Agency, April 2013.

Appendix A

Additional Base Case Inventory Results
By Model Year Group and Emissions Process

Appendix A

Additional Base Case Inventory Results
By Model Year Group and Emissions Process

The following contains additional emission inventory reporting for the Base Case by model year group and emissions process. The emissions process distinctions for exhaust and evaporative emissions as modeled by MOVES2014 are retained in these results. The model year groups were defined to approximate the differences when exhaust certification standards changed significantly. The light-duty gasoline model year groups are pre-2001, 2001 to 2003, 2004 to 2017, and 2017 and newer; the heavy-duty Diesel model year groups are pre-2007, 2007 to 2009, and 2010 and newer.

Fulton County (GA) Light-Duty Gasoline Base Case Inventory by Model Year Group and Emissions Process:

- Table A-1: Summer 2011
- Table A-2: Winter 2011
- Table A-3: Summer 2022
- Table A-4: Winter 2022
- Table A-5: Summer 2050
- Table A-6: Winter 2050

Fulton County (GA) Heavy-Duty Diesel Base Case Inventory by Model Year Group and Emissions Process:

- Table A-7: Summer 2011
- Table A-8: Winter 2011
- Table A-9: Summer 2022
- Table A-10: Winter 2022
- Table A-11: Summer 2050
- Table A-12: Winter 2050

Maricopa County (AZ) Light-Duty Gasoline Base Case Inventory by Model Year Group and Emissions Process:

- Table A-13: Summer 2011
- Table A-14: Winter 2011
- Table A-15: Summer 2022
- Table A-16: Winter 2022
- Table A-17: Summer 2050
- Table A-18: Winter 2050

Maricopa County (AZ) Heavy-Duty Diesel Base Case Inventory by Model Year Group and Emissions Process:

- Table A-19: Summer 2011
- Table A-20: Winter 2011
- Table A-21: Summer 2022
- Table A-22: Winter 2022
- Table A-23: Summer 2050
- Table A-24: Winter 2050

Wayne County (MI) Light-Duty Gasoline Base Case Inventory by Model Year Group and Emissions Process:

- Table A-25: Summer 2011
- Table A-26: Winter 2011
- Table A-27: Summer 2022
- Table A-28: Winter 2022
- Table A-29: Summer 2050
- Table A-30: Winter 2050

Wayne County (MI) Heavy-Duty Diesel Base Case Inventory by Model Year Group and Emissions Process:

- Table A-31: Summer 2011
- Table A-32: Winter 2011
- Table A-33: Summer 2022
- Table A-34: Winter 2022
- Table A-35: Summer 2050
- Table A-36: Winter 2050

Table A-1

Fulton County (GA) Base Case Inventory (Tons per Average Day), Summer 2011

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group: Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	14.70	1.70	2.04	0.00	18.44
	Exhaust Subtotal	9.87	1.14	1.11	0.00	12.12
	Running Exhaust	4.61	0.41	0.32	0.00	5.33
	Exhaust Start	5.26	0.73	0.79	0.00	6.79
	Non-Exhaust Subtotal	4.83	0.55	0.93	0.00	6.32
	Permeation	1.53	0.10	0.32	0.00	1.95
	Vapor Venting	2.09	0.27	0.22	0.00	2.58
	Fuel Leaks	0.79	0.09	0.19	0.00	1.07
	Refueling Vapor	0.32	0.05	0.03	0.00	0.40
	Refueling Spillage	0.10	0.05	0.18	0.00	0.32
CO	Total	142.83	34.06	55.13	0.00	232.03
	Running Exhaust	111.39	28.53	47.82	0.00	187.74
	Exhaust Start	31.44	5.54	7.31	0.00	44.29
NOx	Total	17.82	3.78	2.48	0.00	24.08
	Running Exhaust	13.51	2.85	1.89	0.00	18.25
	Exhaust Start	4.31	0.93	0.59	0.00	5.83
PM2.5	Total	0.139	0.036	0.079	0.000	0.254
	Running Exhaust	0.108	0.030	0.067	0.000	0.204
	Exhaust Start	0.032	0.006	0.012	0.000	0.050

Table A-2

Fulton County (GA) Base Case Inventory (Tons per Average Day), Winter 2011

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group: Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	13.14	1.93	2.76	0.00	17.83
	Exhaust Subtotal	10.73	1.63	2.29	0.00	14.66
	Running Exhaust	3.19	0.24	0.19	0.00	3.62
	Exhaust Start	7.55	1.39	2.10	0.00	11.04
	Non-Exhaust Subtotal	2.40	0.30	0.47	0.00	3.17
	Permeation	0.28	0.02	0.06	0.00	0.35
	Vapor Venting	1.16	0.14	0.10	0.00	1.40
	Fuel Leaks	0.72	0.08	0.17	0.00	0.97
	Refueling Vapor	0.17	0.03	0.01	0.00	0.21
	Refueling Spillage	0.08	0.04	0.13	0.00	0.25
CO	Total	122.72	23.14	41.17	0.00	187.03
	Running Exhaust	63.84	13.63	22.71	0.00	100.18
	Exhaust Start	58.88	9.50	18.46	0.00	86.85
NOx	Total	18.06	3.64	2.69	0.00	24.39
	Running Exhaust	13.28	2.64	1.75	0.00	17.67
	Exhaust Start	4.78	1.00	0.94	0.00	6.72
PM2.5	Total	0.381	0.075	0.081	0.000	0.537
	Running Exhaust	0.243	0.058	0.047	0.000	0.348
	Exhaust Start	0.138	0.017	0.034	0.000	0.188

Table A-3

Fulton County (GA) Base Case Inventory (Tons per Average Day), Summer 2022

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group: Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	1.82	0.69	3.72	0.95	7.18
	Exhaust Subtotal	0.91	0.34	2.01	0.41	3.68
	Running Exhaust	0.35	0.10	0.43	0.11	0.99
	Exhaust Start	0.56	0.24	1.58	0.30	2.68
	Non-Exhaust Subtotal	0.91	0.35	1.71	0.54	3.50
	Permeation	0.25	0.03	0.40	0.15	0.83
	Vapor Venting	0.36	0.09	0.52	0.12	1.10
	Fuel Leaks	0.26	0.21	0.62	0.15	1.24
	Refueling Vapor	0.02	0.01	0.02	0.01	0.07
	Refueling Spillage	0.01	0.01	0.15	0.11	0.27
CO	Total	10.99	9.68	89.98	22.50	133.15
	Running Exhaust	8.32	7.66	76.14	19.46	111.58
	Exhaust Start	2.67	2.02	13.84	3.04	21.57
NOx	Total	1.65	0.79	2.59	0.67	5.70
	Running Exhaust	1.18	0.45	1.49	0.48	3.60
	Exhaust Start	0.47	0.34	1.10	0.19	2.10
PM2.5	Total	0.017	0.012	0.129	0.049	0.207
	Running Exhaust	0.012	0.010	0.105	0.042	0.168
	Exhaust Start	0.005	0.003	0.024	0.007	0.039

Table A-4

Fulton County (GA) Base Case Inventory (Tons per Average Day), Winter 2022

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group: Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	1.53	0.69	3.74	1.31	7.27
	Exhaust Subtotal	1.04	0.45	2.76	1.01	5.27
	Running Exhaust	0.24	0.06	0.26	0.07	0.64
	Exhaust Start	0.80	0.39	2.50	0.94	4.63
	Non-Exhaust Subtotal	0.49	0.24	0.97	0.30	2.01
	Permeation	0.05	0.00	0.07	0.03	0.15
	Vapor Venting	0.19	0.04	0.22	0.05	0.50
	Fuel Leaks	0.24	0.19	0.56	0.13	1.12
	Refueling Vapor	0.01	0.01	0.01	0.01	0.04
	Refueling Spillage	0.01	0.01	0.11	0.08	0.21
CO	Total	9.73	6.80	61.44	17.32	95.28
	Running Exhaust	4.66	3.67	36.36	9.20	53.90
	Exhaust Start	5.07	3.13	25.07	8.12	41.39
NOx	Total	1.68	0.77	2.89	0.96	6.31
	Running Exhaust	1.17	0.42	1.39	0.44	3.41
	Exhaust Start	0.52	0.35	1.50	0.52	2.89
PM2.5	Total	0.048	0.027	0.136	0.046	0.257
	Running Exhaust	0.028	0.018	0.074	0.029	0.149
	Exhaust Start	0.021	0.008	0.062	0.016	0.108

Table A-5

Fulton County (GA) Base Case Inventory (Tons per Average Day), Summer 2050

Pollutant	Emissions Process	Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
		Light-Duty Gasoline, By Model Year Group				
THC	Total	0.00	0.00	0.00	3.30	3.30
	Exhaust Subtotal	0.00	0.00	0.00	1.11	1.11
	Running Exhaust	0.00	0.00	0.00	0.26	0.26
	Exhaust Start	0.00	0.00	0.00	0.86	0.86
	Non-Exhaust Subtotal	0.00	0.00	0.00	2.19	2.19
	Permeation	0.00	0.00	0.00	0.28	0.28
	Vapor Venting	0.00	0.00	0.00	0.31	0.31
	Fuel Leaks	0.00	0.00	0.00	1.35	1.35
	Refueling Vapor	0.00	0.00	0.00	0.02	0.02
	Refueling Spillage	0.00	0.00	0.00	0.23	0.23
CO	Total	0.00	0.00	0.00	57.75	57.75
	Running Exhaust	0.00	0.00	0.00	48.51	48.51
	Exhaust Start	0.00	0.00	0.00	9.23	9.23
NOx	Total	0.00	0.00	0.00	1.42	1.42
	Running Exhaust	0.00	0.00	0.00	0.70	0.70
	Exhaust Start	0.00	0.00	0.00	0.72	0.72
PM2.5	Total	0.000	0.000	0.000	0.146	0.146
	Running Exhaust	0.000	0.000	0.000	0.118	0.118
	Exhaust Start	0.000	0.000	0.000	0.028	0.028

Table A-6

Fulton County (GA) Base Case Inventory (Tons per Average Day), Winter 2050

Pollutant	Emissions Process	Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
		Light-Duty Gasoline, By Model Year Group				
THC	Total	0.00	0.00	0.00	4.98	4.98
	Exhaust Subtotal	0.00	0.00	0.00	3.39	3.39
	Running Exhaust	0.00	0.00	0.00	0.16	0.16
	Exhaust Start	0.00	0.00	0.00	3.23	3.23
	Non-Exhaust Subtotal	0.00	0.00	0.00	1.59	1.59
	Permeation	0.00	0.00	0.00	0.05	0.05
	Vapor Venting	0.00	0.00	0.00	0.13	0.13
	Fuel Leaks	0.00	0.00	0.00	1.22	1.22
	Refueling Vapor	0.00	0.00	0.00	0.01	0.01
	Refueling Spillage	0.00	0.00	0.00	0.18	0.18
CO	Total	0.00	0.00	0.00	50.41	50.41
	Running Exhaust	0.00	0.00	0.00	23.10	23.10
	Exhaust Start	0.00	0.00	0.00	27.30	27.30
NOx	Total	0.00	0.00	0.00	2.56	2.56
	Running Exhaust	0.00	0.00	0.00	0.66	0.66
	Exhaust Start	0.00	0.00	0.00	1.90	1.90
PM2.5	Total	0.000	0.000	0.000	0.147	0.147
	Running Exhaust	0.000	0.000	0.000	0.083	0.083
	Exhaust Start	0.000	0.000	0.000	0.064	0.064

Table A-7

Fulton County (GA) Base Case Inventory (Tons per Average Day), Summer 2011

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group: Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	1.23	0.13	0.05	1.41
	Running Exhaust	1.09	0.07	0.02	1.19
	Exhaust Start	0.00	0.00	0.00	0.00
	Crankcase	0.04	0.00	0.00	0.04
	Hotelling/APU	0.10	0.06	0.02	0.18
CO	Total	5.80	0.53	0.20	6.53
	Running Exhaust	5.19	0.30	0.10	5.59
	Exhaust Start	0.39	0.14	0.06	0.59
	Crankcase	0.07	0.00	0.00	0.07
	Hotelling/APU	0.15	0.09	0.04	0.29
NOx	Total	11.92	3.23	0.32	15.47
	Running Exhaust	11.54	3.02	0.24	14.81
	Exhaust Start	0.05	0.02	0.01	0.07
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.33	0.19	0.07	0.59
PM2.5	Total	0.841	0.014	0.006	0.861
	Running Exhaust	0.666	0.009	0.003	0.678
	Exhaust Start	0.002	0.000	0.000	0.002
	Crankcase	0.164	0.005	0.002	0.171
	Hotelling/APU	0.009	0.000	0.000	0.010

Table A-8

Fulton County (GA) Base Case Inventory (Tons per Average Day), Winter 2011

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group: Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	1.15	0.15	0.05	1.35
	Running Exhaust	0.94	0.06	0.02	1.02
	Exhaust Start	0.08	0.03	0.01	0.12
	Crankcase	0.04	0.00	0.00	0.04
	Hotelling/APU	0.09	0.05	0.02	0.17
CO	Total	4.86	0.48	0.18	5.52
	Running Exhaust	4.26	0.26	0.09	4.60
	Exhaust Start	0.39	0.14	0.06	0.59
	Crankcase	0.06	0.00	0.00	0.06
	Hotelling/APU	0.14	0.09	0.04	0.27
NOx	Total	13.51	3.71	0.38	17.60
	Running Exhaust	13.07	3.47	0.28	16.81
	Exhaust Start	0.05	0.02	0.01	0.07
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.40	0.22	0.09	0.72
PM2.5	Total	0.752	0.012	0.005	0.769
	Running Exhaust	0.596	0.008	0.003	0.606
	Exhaust Start	0.002	0.000	0.000	0.002
	Crankcase	0.146	0.005	0.002	0.152
	Hotelling/APU	0.009	0.000	0.000	0.009

Table A-9

Fulton County (GA) Base Case Inventory (Tons per Average Day), Summer 2022

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group: Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.18	0.05	0.30	0.53
	Running Exhaust	0.16	0.04	0.18	0.37
	Exhaust Start	0.00	0.00	0.00	0.00
	Crankcase	0.01	0.00	0.00	0.01
	Hotelling/APU	0.02	0.01	0.12	0.15
CO	Total	0.93	0.24	1.44	2.61
	Running Exhaust	0.76	0.14	0.75	1.65
	Exhaust Start	0.13	0.08	0.47	0.68
	Crankcase	0.01	0.00	0.00	0.01
	Hotelling/APU	0.03	0.02	0.23	0.27
NOx	Total	1.53	0.84	2.28	4.65
	Running Exhaust	1.46	0.79	1.81	4.05
	Exhaust Start	0.02	0.01	0.07	0.10
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.06	0.04	0.40	0.49
PM2.5	Total	0.111	0.005	0.041	0.157
	Running Exhaust	0.088	0.003	0.024	0.115
	Exhaust Start	0.001	0.001	0.001	0.002
	Crankcase	0.021	0.002	0.014	0.036
	Hotelling/APU	0.002	0.000	0.002	0.004

Table A-10

Fulton County (GA) Base Case Inventory (Tons per Average Day), Winter 2022

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group: Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.18	0.06	0.37	0.61
	Running Exhaust	0.13	0.03	0.16	0.32
	Exhaust Start	0.03	0.02	0.10	0.15
	Crankcase	0.01	0.00	0.00	0.01
	Hotelling/APU	0.02	0.01	0.11	0.14
CO	Total	0.76	0.21	1.31	2.28
	Running Exhaust	0.60	0.11	0.62	1.33
	Exhaust Start	0.13	0.08	0.47	0.68
	Crankcase	0.01	0.00	0.00	0.01
	Hotelling/APU	0.02	0.02	0.21	0.26
NOx	Total	1.72	0.92	2.60	5.24
	Running Exhaust	1.63	0.87	2.05	4.55
	Exhaust Start	0.02	0.01	0.07	0.10
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.07	0.05	0.48	0.60
PM2.5	Total	0.099	0.004	0.037	0.141
	Running Exhaust	0.079	0.002	0.022	0.103
	Exhaust Start	0.001	0.001	0.001	0.002
	Crankcase	0.018	0.002	0.013	0.033
	Hotelling/APU	0.002	0.000	0.002	0.003

Table A-11

Fulton County (GA) Base Case Inventory (Tons per Average Day), Summer 2050

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.00	0.00	0.45	0.45
	Running Exhaust	0.00	0.00	0.28	0.28
	Exhaust Start	0.00	0.00	0.01	0.01
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	0.16	0.16
CO	Total	0.00	0.00	2.38	2.38
	Running Exhaust	0.00	0.00	1.16	1.16
	Exhaust Start	0.00	0.00	0.92	0.92
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	0.31	0.31
NOx	Total	0.00	0.00	3.16	3.16
	Running Exhaust	0.00	0.00	2.50	2.50
	Exhaust Start	0.00	0.00	0.12	0.12
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	0.54	0.54
PM2.5	Total	0.000	0.000	0.061	0.061
	Running Exhaust	0.000	0.000	0.037	0.037
	Exhaust Start	0.000	0.000	0.000	0.000
	Crankcase	0.000	0.000	0.021	0.021
	Hotelling/APU	0.000	0.000	0.003	0.003

Table A-12

Fulton County (GA) Base Case Inventory (Tons per Average Day), Winter 2050

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.00	0.00	0.61	0.61
	Running Exhaust	0.00	0.00	0.25	0.25
	Exhaust Start	0.00	0.00	0.21	0.21
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	0.15	0.15
CO	Total	0.00	0.00	2.16	2.16
	Running Exhaust	0.00	0.00	0.96	0.96
	Exhaust Start	0.00	0.00	0.92	0.92
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	0.29	0.29
NOx	Total	0.00	0.00	3.63	3.63
	Running Exhaust	0.00	0.00	2.85	2.85
	Exhaust Start	0.00	0.00	0.12	0.12
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	0.65	0.65
PM2.5	Total	0.000	0.000	0.055	0.055
	Running Exhaust	0.000	0.000	0.033	0.033
	Exhaust Start	0.000	0.000	0.000	0.000
	Crankcase	0.000	0.000	0.019	0.019
	Hotelling/APU	0.000	0.000	0.003	0.003

Table A-13

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Summer 2011

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	38.40	6.06	7.32	0.00	51.79
	Exhaust Subtotal	17.23	3.10	3.22	0.00	23.55
	Running Exhaust	5.82	0.50	0.45	0.00	6.77
	Exhaust Start	11.41	2.59	2.77	0.00	16.78
	Non-Exhaust Subtotal	21.18	2.96	4.10	0.00	28.24
	Permeation	8.23	0.66	1.87	0.00	10.76
	Vapor Venting	8.47	1.67	1.32	0.00	11.46
	Fuel Leaks	2.47	0.28	0.54	0.00	3.30
	Refueling Vapor	1.89	0.28	0.17	0.00	2.35
	Refueling Spillage	0.11	0.06	0.20	0.00	0.37
CO	Total	278.16	93.19	147.93	0.00	519.28
	Running Exhaust	192.38	66.06	111.49	0.00	369.93
	Exhaust Start	85.79	27.13	36.43	0.00	149.35
NOx	Total	38.34	7.94	5.17	0.00	51.46
	Running Exhaust	27.58	4.53	3.02	0.00	35.13
	Exhaust Start	10.76	3.41	2.16	0.00	16.32
PM2.5	Total	0.380	0.075	0.140	0.000	0.594
	Running Exhaust	0.268	0.063	0.118	0.000	0.449
	Exhaust Start	0.111	0.012	0.022	0.000	0.145

Table A-14

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Winter 2011

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	30.20	5.23	6.62	0.00	42.05
	Exhaust Subtotal	19.99	3.75	4.72	0.00	28.47
	Running Exhaust	5.31	0.41	0.37	0.00	6.08
	Exhaust Start	14.69	3.34	4.36	0.00	22.39
	Non-Exhaust Subtotal	10.20	1.47	1.90	0.00	13.57
	Permeation	1.70	0.14	0.38	0.00	2.23
	Vapor Venting	4.86	0.83	0.68	0.00	6.38
	Fuel Leaks	2.45	0.28	0.54	0.00	3.28
	Refueling Vapor	1.08	0.16	0.09	0.00	1.33
	Refueling Spillage	0.11	0.06	0.19	0.00	0.36
CO	Total	244.48	75.21	123.66	0.00	443.36
	Running Exhaust	123.50	39.25	65.73	0.00	228.48
	Exhaust Start	120.99	35.95	57.93	0.00	214.87
NOx	Total	39.25	8.07	5.87	0.00	53.19
	Running Exhaust	27.66	4.39	2.91	0.00	34.96
	Exhaust Start	11.59	3.69	2.96	0.00	18.23
PM2.5	Total	0.729	0.128	0.154	0.000	1.011
	Running Exhaust	0.485	0.107	0.118	0.000	0.709
	Exhaust Start	0.244	0.021	0.037	0.000	0.302

Table A-15

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Summer 2022

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	8.89	1.73	14.99	3.44	29.05
	Exhaust Subtotal	2.58	0.62	6.96	1.32	11.48
	Running Exhaust	0.75	0.08	1.02	0.26	2.11
	Exhaust Start	1.83	0.54	5.95	1.06	9.38
	Non-Exhaust Subtotal	6.31	1.11	8.03	2.12	17.57
	Permeation	2.34	0.11	2.40	0.83	5.68
	Vapor Venting	2.35	0.45	3.52	0.69	7.02
	Fuel Leaks	1.31	0.51	1.77	0.41	4.00
	Refueling Vapor	0.28	0.03	0.13	0.07	0.52
	Refueling Spillage	0.02	0.01	0.20	0.12	0.34
CO	Total	41.36	14.85	261.87	62.31	380.39
	Running Exhaust	28.74	9.52	193.01	47.69	278.96
	Exhaust Start	12.63	5.33	68.86	14.62	101.44
NOx	Total	7.03	1.33	7.99	2.03	18.38
	Running Exhaust	4.41	0.62	4.23	1.36	10.62
	Exhaust Start	2.62	0.71	3.76	0.66	7.76
PM2.5	Total	0.077	0.019	0.268	0.092	0.456
	Running Exhaust	0.050	0.014	0.218	0.078	0.361
	Exhaust Start	0.027	0.004	0.049	0.014	0.094

Table A-16

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Winter 2022

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	6.21	1.49	12.15	3.28	23.13
	Exhaust Subtotal	2.91	0.71	7.74	2.17	13.53
	Running Exhaust	0.68	0.07	0.83	0.21	1.78
	Exhaust Start	2.22	0.65	6.92	1.96	11.75
	Non-Exhaust Subtotal	3.30	0.78	4.41	1.11	9.60
	Permeation	0.49	0.02	0.50	0.17	1.18
	Vapor Venting	1.34	0.22	1.88	0.37	3.81
	Fuel Leaks	1.30	0.51	1.76	0.41	3.98
	Refueling Vapor	0.17	0.02	0.07	0.04	0.30
	Refueling Spillage	0.02	0.01	0.19	0.12	0.33
CO	Total	34.39	12.60	206.41	52.00	305.40
	Running Exhaust	18.18	5.75	115.00	28.16	167.09
	Exhaust Start	16.22	6.85	91.41	23.83	138.31
NOx	Total	7.24	1.36	8.86	2.65	20.11
	Running Exhaust	4.44	0.60	4.10	1.32	10.46
	Exhaust Start	2.80	0.76	4.77	1.34	9.65
PM2.5	Total	0.150	0.032	0.297	0.099	0.578
	Running Exhaust	0.091	0.024	0.217	0.078	0.410
	Exhaust Start	0.059	0.008	0.080	0.021	0.167

Table A-17

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Summer 2050

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	0.00	0.00	0.00	16.95	16.95
	Exhaust Subtotal	0.00	0.00	0.00	4.48	4.48
	Running Exhaust	0.00	0.00	0.00	0.81	0.81
	Exhaust Start	0.00	0.00	0.00	3.67	3.67
	Non-Exhaust Subtotal	0.00	0.00	0.00	12.47	12.47
	Permeation	0.00	0.00	0.00	1.87	1.87
	Vapor Venting	0.00	0.00	0.00	4.89	4.89
	Fuel Leaks	0.00	0.00	0.00	5.14	5.14
	Refueling Vapor	0.00	0.00	0.00	0.22	0.22
	Refueling Spillage	0.00	0.00	0.00	0.36	0.36
CO	Total	0.00	0.00	0.00	212.84	212.84
	Running Exhaust	0.00	0.00	0.00	159.79	159.79
	Exhaust Start	0.00	0.00	0.00	53.05	53.05
NOx	Total	0.00	0.00	0.00	6.03	6.03
	Running Exhaust	0.00	0.00	0.00	3.00	3.00
	Exhaust Start	0.00	0.00	0.00	3.03	3.03
PM2.5	Total	0.000	0.000	0.000	0.363	0.363
	Running Exhaust	0.000	0.000	0.000	0.297	0.297
	Exhaust Start	0.000	0.000	0.000	0.066	0.066

Table A-18

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Winter 2050

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	0.00	0.00	0.00	17.07	17.07
	Exhaust Subtotal	0.00	0.00	0.00	8.52	8.52
	Running Exhaust	0.00	0.00	0.00	0.66	0.66
	Exhaust Start	0.00	0.00	0.00	7.87	7.87
	Non-Exhaust Subtotal	0.00	0.00	0.00	8.55	8.55
	Permeation	0.00	0.00	0.00	0.39	0.39
	Vapor Venting	0.00	0.00	0.00	2.58	2.58
	Fuel Leaks	0.00	0.00	0.00	5.10	5.10
	Refueling Vapor	0.00	0.00	0.00	0.13	0.13
	Refueling Spillage	0.00	0.00	0.00	0.35	0.35
CO	Total	0.00	0.00	0.00	188.31	188.31
	Running Exhaust	0.00	0.00	0.00	94.88	94.88
	Exhaust Start	0.00	0.00	0.00	93.43	93.43
NOx	Total	0.00	0.00	0.00	8.94	8.94
	Running Exhaust	0.00	0.00	0.00	2.91	2.91
	Exhaust Start	0.00	0.00	0.00	6.04	6.04
PM2.5	Total	0.000	0.000	0.000	0.397	0.397
	Running Exhaust	0.000	0.000	0.000	0.295	0.295
	Exhaust Start	0.000	0.000	0.000	0.101	0.101

Table A-19

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Summer 2011

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	4.16	0.51	0.15	4.83
	Running Exhaust	3.64	0.29	0.08	4.00
	Exhaust Start	0.00	0.00	0.00	0.01
	Crankcase	0.16	0.00	0.00	0.16
	Hotelling/APU	0.37	0.22	0.07	0.66
CO	Total	18.61	1.84	0.58	21.03
	Running Exhaust	17.13	1.20	0.34	18.67
	Exhaust Start	0.64	0.26	0.11	1.01
	Crankcase	0.32	0.00	0.00	0.32
	Hotelling/APU	0.52	0.38	0.14	1.03
NOx	Total	48.18	14.63	1.31	64.13
	Running Exhaust	46.48	13.76	1.03	61.27
	Exhaust Start	0.09	0.03	0.01	0.13
	Crankcase	0.05	0.00	0.00	0.05
	Hotelling/APU	1.56	0.85	0.28	2.68
PM2.5	Total	3.152	0.070	0.023	3.245
	Running Exhaust	2.529	0.042	0.013	2.585
	Exhaust Start	0.003	0.000	0.000	0.003
	Crankcase	0.584	0.026	0.008	0.619
	Hotelling/APU	0.037	0.001	0.001	0.039

Table A-20

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Winter 2011

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	4.45	0.56	0.17	5.19
	Running Exhaust	3.81	0.30	0.08	4.20
	Exhaust Start	0.08	0.03	0.01	0.12
	Crankcase	0.17	0.00	0.00	0.17
	Hotelling/APU	0.39	0.23	0.08	0.69
CO	Total	19.00	1.91	0.60	21.51
	Running Exhaust	17.47	1.25	0.35	19.07
	Exhaust Start	0.64	0.26	0.11	1.01
	Crankcase	0.31	0.00	0.00	0.31
	Hotelling/APU	0.57	0.40	0.14	1.11
NOx	Total	56.34	17.18	1.54	75.06
	Running Exhaust	54.36	16.15	1.20	71.71
	Exhaust Start	0.09	0.03	0.01	0.13
	Crankcase	0.06	0.00	0.00	0.06
	Hotelling/APU	1.83	1.00	0.32	3.15
PM2.5	Total	3.330	0.074	0.024	3.428
	Running Exhaust	2.671	0.045	0.014	2.730
	Exhaust Start	0.003	0.000	0.000	0.003
	Crankcase	0.617	0.028	0.009	0.654
	Hotelling/APU	0.039	0.001	0.001	0.041

Table A-21

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Summer 2022

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.27	0.14	1.55	1.97
	Running Exhaust	0.24	0.09	0.86	1.19
	Exhaust Start	0.00	0.00	0.01	0.01
	Crankcase	0.01	0.00	0.00	0.01
	Hotelling/APU	0.02	0.06	0.68	0.76
CO	Total	1.28	0.59	6.08	7.95
	Running Exhaust	1.12	0.36	3.55	5.03
	Exhaust Start	0.11	0.13	1.23	1.47
	Crankcase	0.02	0.00	0.00	0.03
	Hotelling/APU	0.03	0.09	1.30	1.42
NOx	Total	2.88	3.29	14.36	20.53
	Running Exhaust	2.76	3.06	11.56	17.38
	Exhaust Start	0.02	0.02	0.15	0.19
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.09	0.21	2.66	2.96
PM2.5	Total	0.180	0.019	0.262	0.462
	Running Exhaust	0.144	0.012	0.155	0.311
	Exhaust Start	0.001	0.000	0.000	0.001
	Crankcase	0.034	0.007	0.095	0.136
	Hotelling/APU	0.002	0.000	0.012	0.014

Table A-22

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Winter 2022

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.30	0.17	1.78	2.24
	Running Exhaust	0.25	0.09	0.91	1.25
	Exhaust Start	0.02	0.02	0.14	0.18
	Crankcase	0.01	0.00	0.00	0.01
	Hotelling/APU	0.02	0.06	0.72	0.80
CO	Total	1.25	0.61	6.28	8.13
	Running Exhaust	1.09	0.37	3.68	5.14
	Exhaust Start	0.11	0.13	1.23	1.47
	Crankcase	0.02	0.00	0.00	0.02
	Hotelling/APU	0.03	0.10	1.37	1.50
NOx	Total	3.33	3.85	16.80	23.98
	Running Exhaust	3.19	3.58	13.53	20.30
	Exhaust Start	0.02	0.02	0.15	0.19
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.11	0.25	3.13	3.49
PM2.5	Total	0.190	0.020	0.277	0.488
	Running Exhaust	0.152	0.012	0.164	0.328
	Exhaust Start	0.001	0.000	0.000	0.001
	Crankcase	0.036	0.008	0.100	0.144
	Hotelling/APU	0.002	0.000	0.012	0.015

Table A-23

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Summer 2050

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.00	0.00	3.11	3.11
	Running Exhaust	0.00	0.00	1.68	1.68
	Exhaust Start	0.00	0.00	0.01	0.01
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	1.42	1.42
CO	Total	0.00	0.00	12.23	12.23
	Running Exhaust	0.00	0.00	6.90	6.90
	Exhaust Start	0.00	0.00	2.64	2.64
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	2.69	2.69
NOx	Total	0.00	0.00	27.06	27.06
	Running Exhaust	0.00	0.00	21.30	21.30
	Exhaust Start	0.00	0.00	0.27	0.27
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	5.49	5.49
PM2.5	Total	0.000	0.000	0.514	0.514
	Running Exhaust	0.000	0.000	0.303	0.303
	Exhaust Start	0.000	0.000	0.001	0.001
	Crankcase	0.000	0.000	0.185	0.185
	Hotelling/APU	0.000	0.000	0.024	0.024

Table A-24

Maricopa County (AZ) Base Case Inventory (Tons per Average Day), Winter 2050

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.00	0.00	3.57	3.57
	Running Exhaust	0.00	0.00	1.76	1.76
	Exhaust Start	0.00	0.00	0.31	0.31
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	1.49	1.49
CO	Total	0.00	0.00	12.63	12.63
	Running Exhaust	0.00	0.00	7.15	7.15
	Exhaust Start	0.00	0.00	2.64	2.64
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	2.84	2.84
NOx	Total	0.00	0.00	31.75	31.75
	Running Exhaust	0.00	0.00	25.01	25.01
	Exhaust Start	0.00	0.00	0.27	0.27
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	6.47	6.47
PM2.5	Total	0.000	0.000	0.543	0.543
	Running Exhaust	0.000	0.000	0.320	0.320
	Exhaust Start	0.000	0.000	0.001	0.001
	Crankcase	0.000	0.000	0.196	0.196
	Hotelling/APU	0.000	0.000	0.026	0.026

Table A-25

Wayne County (MI) Base Case Inventory (Tons per Average Day), Summer 2011

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	20.46	3.71	3.35	0.00	27.52
	Exhaust Subtotal	13.38	2.41	1.83	0.00	17.62
	Running Exhaust	5.44	0.87	0.51	0.00	6.82
	Exhaust Start	7.95	1.54	1.32	0.00	10.81
	Non-Exhaust Subtotal	7.07	1.30	1.53	0.00	9.90
	Permeation	1.64	0.15	0.44	0.00	2.23
	Vapor Venting	2.61	0.53	0.39	0.00	3.53
	Fuel Leaks	0.96	0.13	0.27	0.00	1.37
	Refueling Vapor	1.75	0.41	0.19	0.00	2.36
	Refueling Spillage	0.11	0.07	0.23	0.00	0.41
CO	Total	172.64	60.12	76.63	0.00	309.39
	Running Exhaust	128.40	48.80	64.84	0.00	242.04
	Exhaust Start	44.24	11.32	11.79	0.00	67.35
NOx	Total	23.12	7.91	4.24	0.00	35.28
	Running Exhaust	17.54	5.99	3.23	0.00	26.77
	Exhaust Start	5.58	1.92	1.01	0.00	8.51
PM2.5	Total	0.166	0.056	0.109	0.000	0.331
	Running Exhaust	0.126	0.045	0.090	0.000	0.261
	Exhaust Start	0.041	0.011	0.019	0.000	0.070

Table A-26

Wayne County (MI) Base Case Inventory (Tons per Average Day), Winter 2011

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	22.58	5.38	7.52	0.00	35.48
	Exhaust Subtotal	19.57	4.82	6.85	0.00	31.23
	Running Exhaust	4.13	0.55	0.32	0.00	5.00
	Exhaust Start	15.43	4.27	6.53	0.00	26.23
	Non-Exhaust Subtotal	3.02	0.57	0.67	0.00	4.25
	Permeation	0.17	0.02	0.05	0.00	0.23
	Vapor Venting	1.02	0.17	0.10	0.00	1.30
	Fuel Leaks	0.88	0.12	0.25	0.00	1.25
	Refueling Vapor	0.85	0.20	0.09	0.00	1.14
	Refueling Spillage	0.09	0.06	0.19	0.00	0.34
CO	Total	219.54	54.24	87.89	0.00	361.67
	Running Exhaust	90.43	26.85	35.45	0.00	152.74
	Exhaust Start	129.10	27.39	52.44	0.00	208.93
NOx	Total	23.70	7.63	4.82	0.00	36.15
	Running Exhaust	17.20	5.51	2.97	0.00	25.67
	Exhaust Start	6.50	2.12	1.86	0.00	10.48
PM2.5	Total	0.924	0.218	0.171	0.000	1.314
	Running Exhaust	0.517	0.156	0.064	0.000	0.736
	Exhaust Start	0.408	0.063	0.107	0.000	0.578

Table A-27

Wayne County (MI) Base Case Inventory (Tons per Average Day), Summer 2022

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group: Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	2.53	0.55	5.40	1.22	9.70
	Exhaust Subtotal	1.28	0.26	3.05	0.52	5.11
	Running Exhaust	0.44	0.05	0.62	0.14	1.25
	Exhaust Start	0.84	0.21	2.43	0.38	3.86
	Non-Exhaust Subtotal	1.25	0.29	2.35	0.71	4.59
	Permeation	0.31	0.02	0.46	0.16	0.96
	Vapor Venting	0.47	0.09	0.95	0.18	1.69
	Fuel Leaks	0.33	0.15	0.68	0.18	1.34
	Refueling Vapor	0.13	0.02	0.09	0.06	0.31
	Refueling Spillage	0.01	0.00	0.16	0.12	0.29
CO	Total	14.15	6.04	116.51	25.37	162.07
	Running Exhaust	10.13	4.44	95.30	21.31	131.18
	Exhaust Start	4.03	1.60	21.20	4.06	30.89
NOx	Total	2.25	0.54	3.72	0.90	7.42
	Running Exhaust	1.58	0.27	2.16	0.65	4.67
	Exhaust Start	0.67	0.26	1.56	0.26	2.75
PM2.5	Total	0.020	0.008	0.149	0.054	0.231
	Running Exhaust	0.014	0.006	0.119	0.046	0.184
	Exhaust Start	0.006	0.002	0.030	0.009	0.047

Table A-28

Wayne County (MI) Base Case Inventory (Tons per Average Day), Winter 2022

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group: Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	2.53	0.68	6.98	2.85	13.03
	Exhaust Subtotal	1.96	0.50	5.90	2.50	10.86
	Running Exhaust	0.34	0.03	0.40	0.09	0.86
	Exhaust Start	1.62	0.47	5.50	2.41	10.00
	Non-Exhaust Subtotal	0.57	0.18	1.08	0.35	2.17
	Permeation	0.03	0.00	0.05	0.02	0.10
	Vapor Venting	0.16	0.02	0.23	0.04	0.45
	Fuel Leaks	0.31	0.14	0.62	0.16	1.22
	Refueling Vapor	0.07	0.01	0.04	0.03	0.15
	Refueling Spillage	0.01	0.00	0.14	0.10	0.25
CO	Total	19.03	5.83	106.23	31.72	162.81
	Running Exhaust	7.06	2.49	52.86	11.73	74.14
	Exhaust Start	11.96	3.34	53.37	19.99	88.66
NOx	Total	2.32	0.53	4.34	1.52	8.71
	Running Exhaust	1.55	0.25	1.99	0.59	4.39
	Exhaust Start	0.77	0.28	2.35	0.92	4.32
PM2.5	Total	0.121	0.032	0.242	0.071	0.466
	Running Exhaust	0.058	0.019	0.085	0.033	0.195
	Exhaust Start	0.064	0.012	0.157	0.038	0.271

Table A-29

Wayne County (MI) Base Case Inventory (Tons per Average Day), Summer 2050

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	0.00	0.00	0.00	3.70	3.70
	Exhaust Subtotal	0.00	0.00	0.00	1.22	1.22
	Running Exhaust	0.00	0.00	0.00	0.27	0.27
	Exhaust Start	0.00	0.00	0.00	0.94	0.94
	Non-Exhaust Subtotal	0.00	0.00	0.00	2.49	2.49
	Permeation	0.00	0.00	0.00	0.24	0.24
	Vapor Venting	0.00	0.00	0.00	0.82	0.82
	Fuel Leaks	0.00	0.00	0.00	1.12	1.12
	Refueling Vapor	0.00	0.00	0.00	0.10	0.10
	Refueling Spillage	0.00	0.00	0.00	0.20	0.20
CO	Total	0.00	0.00	0.00	56.17	56.17
	Running Exhaust	0.00	0.00	0.00	45.92	45.92
	Exhaust Start	0.00	0.00	0.00	10.25	10.25
NOx	Total	0.00	0.00	0.00	1.65	1.65
	Running Exhaust	0.00	0.00	0.00	0.87	0.87
	Exhaust Start	0.00	0.00	0.00	0.78	0.78
PM2.5	Total	0.000	0.000	0.000	0.129	0.129
	Running Exhaust	0.000	0.000	0.000	0.103	0.103
	Exhaust Start	0.000	0.000	0.000	0.026	0.026

Table A-30

Wayne County (MI) Base Case Inventory (Tons per Average Day), Winter 2050

Pollutant	Emissions Process	Light-Duty Gasoline, By Model Year Group Pre-2000 Model Year	2001 - 2003 Model Year	2004 - 2016 Model Year	2017+ Model Year	Total
THC	Total	0.00	0.00	0.00	7.93	7.93
	Exhaust Subtotal	0.00	0.00	0.00	6.48	6.48
	Running Exhaust	0.00	0.00	0.00	0.18	0.18
	Exhaust Start	0.00	0.00	0.00	6.30	6.30
	Non-Exhaust Subtotal	0.00	0.00	0.00	1.46	1.46
	Permeation	0.00	0.00	0.00	0.03	0.03
	Vapor Venting	0.00	0.00	0.00	0.19	0.19
	Fuel Leaks	0.00	0.00	0.00	1.02	1.02
	Refueling Vapor	0.00	0.00	0.00	0.05	0.05
	Refueling Spillage	0.00	0.00	0.00	0.17	0.17
CO	Total	0.00	0.00	0.00	77.33	77.33
	Running Exhaust	0.00	0.00	0.00	25.38	25.38
	Exhaust Start	0.00	0.00	0.00	51.95	51.95
NOx	Total	0.00	0.00	0.00	3.32	3.32
	Running Exhaust	0.00	0.00	0.00	0.80	0.80
	Exhaust Start	0.00	0.00	0.00	2.52	2.52
PM2.5	Total	0.000	0.000	0.000	0.187	0.187
	Running Exhaust	0.000	0.000	0.000	0.074	0.074
	Exhaust Start	0.000	0.000	0.000	0.114	0.114

Table A-31

Wayne County (MI) Base Case Inventory (Tons per Average Day), Summer 2011

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group: Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	3.51	0.32	0.06	3.89
	Running Exhaust	2.84	0.11	0.03	2.98
	Exhaust Start	0.00	0.00	0.00	0.00
	Crankcase	0.12	0.00	0.00	0.12
	Hotelling/APU	0.54	0.20	0.04	0.78
CO	Total	14.07	0.88	0.21	15.16
	Running Exhaust	12.68	0.45	0.11	13.23
	Exhaust Start	0.35	0.08	0.03	0.47
	Crankcase	0.21	0.00	0.00	0.21
	Hotelling/APU	0.83	0.35	0.07	1.25
NOx	Total	34.83	5.76	0.40	40.99
	Running Exhaust	32.73	5.02	0.26	38.00
	Exhaust Start	0.04	0.01	0.01	0.06
	Crankcase	0.03	0.00	0.00	0.03
	Hotelling/APU	2.03	0.73	0.13	2.89
PM2.5	Total	2.134	0.025	0.006	2.165
	Running Exhaust	1.655	0.015	0.003	1.673
	Exhaust Start	0.002	0.000	0.000	0.002
	Crankcase	0.424	0.009	0.002	0.435
	Hotelling/APU	0.054	0.001	0.001	0.056

Table A-32

Wayne County (MI) Base Case Inventory (Tons per Average Day), Winter 2011

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group: Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	3.06	0.29	0.07	3.42
	Running Exhaust	2.40	0.09	0.02	2.51
	Exhaust Start	0.10	0.03	0.01	0.14
	Crankcase	0.11	0.00	0.00	0.11
	Hotelling/APU	0.46	0.17	0.03	0.66
CO	Total	11.77	0.75	0.18	12.69
	Running Exhaust	10.53	0.37	0.09	10.99
	Exhaust Start	0.35	0.08	0.03	0.47
	Crankcase	0.17	0.00	0.00	0.17
	Hotelling/APU	0.71	0.30	0.06	1.07
NOx	Total	35.45	5.86	0.40	41.71
	Running Exhaust	33.30	5.10	0.26	38.66
	Exhaust Start	0.04	0.01	0.01	0.06
	Crankcase	0.04	0.00	0.00	0.04
	Hotelling/APU	2.07	0.75	0.13	2.96
PM2.5	Total	1.808	0.021	0.005	1.834
	Running Exhaust	1.402	0.013	0.003	1.417
	Exhaust Start	0.002	0.000	0.000	0.002
	Crankcase	0.359	0.008	0.002	0.369
	Hotelling/APU	0.046	0.001	0.001	0.047

Table A-33

Wayne County (MI) Base Case Inventory (Tons per Average Day), Summer 2022

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.37	0.12	0.96	1.46
	Running Exhaust	0.32	0.07	0.41	0.79
	Exhaust Start	0.00	0.00	0.00	0.00
	Crankcase	0.01	0.00	0.00	0.01
	Hotelling/APU	0.04	0.06	0.55	0.65
CO	Total	1.41	0.40	2.93	4.74
	Running Exhaust	1.26	0.25	1.54	3.04
	Exhaust Start	0.07	0.05	0.35	0.47
	Crankcase	0.02	0.00	0.00	0.02
	Hotelling/APU	0.07	0.10	1.04	1.21
NOx	Total	3.22	1.90	6.35	11.46
	Running Exhaust	3.03	1.68	4.33	9.04
	Exhaust Start	0.01	0.01	0.05	0.07
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.18	0.21	1.97	2.35
PM2.5	Total	0.209	0.011	0.103	0.323
	Running Exhaust	0.157	0.007	0.058	0.222
	Exhaust Start	0.000	0.000	0.000	0.000
	Crankcase	0.047	0.004	0.036	0.086
	Hotelling/APU	0.004	0.000	0.009	0.014

Table A-34

Wayne County (MI) Base Case Inventory (Tons per Average Day), Winter 2022

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.34	0.12	0.92	1.38
	Running Exhaust	0.27	0.06	0.34	0.67
	Exhaust Start	0.02	0.02	0.12	0.15
	Crankcase	0.01	0.00	0.00	0.01
	Hotelling/APU	0.04	0.05	0.46	0.55
CO	Total	1.19	0.34	2.51	4.04
	Running Exhaust	1.05	0.21	1.27	2.52
	Exhaust Start	0.07	0.05	0.35	0.47
	Crankcase	0.02	0.00	0.00	0.02
	Hotelling/APU	0.06	0.09	0.88	1.03
NOx	Total	3.27	1.93	6.45	11.65
	Running Exhaust	3.08	1.71	4.38	9.17
	Exhaust Start	0.01	0.01	0.05	0.07
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.18	0.22	2.01	2.41
PM2.5	Total	0.177	0.009	0.088	0.274
	Running Exhaust	0.133	0.006	0.049	0.188
	Exhaust Start	0.000	0.000	0.000	0.000
	Crankcase	0.040	0.003	0.030	0.073
	Hotelling/APU	0.004	0.000	0.008	0.012

Table A-35

Wayne County (MI) Base Case Inventory (Tons per Average Day), Summer 2050

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group: Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.00	0.00	1.27	1.27
	Running Exhaust	0.00	0.00	0.53	0.53
	Exhaust Start	0.00	0.00	0.00	0.00
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	0.73	0.73
CO	Total	0.00	0.00	3.89	3.89
	Running Exhaust	0.00	0.00	2.00	2.00
	Exhaust Start	0.00	0.00	0.50	0.50
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	1.39	1.39
NOx	Total	0.00	0.00	7.87	7.87
	Running Exhaust	0.00	0.00	5.18	5.18
	Exhaust Start	0.00	0.00	0.07	0.07
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	2.62	2.62
PM2.5	Total	0.000	0.000	0.133	0.133
	Running Exhaust	0.000	0.000	0.075	0.075
	Exhaust Start	0.000	0.000	0.000	0.000
	Crankcase	0.000	0.000	0.046	0.046
	Hotelling/APU	0.000	0.000	0.013	0.013

Table A-36

Wayne County (MI) Base Case Inventory (Tons per Average Day), Winter 2050

Pollutant	Emissions Process	Heavy-Duty Diesel, By Model Year Group: Pre-2007 Model Year	2007 - 2009 Model Year	2010+ Model Year	Total
THC	Total	0.00	0.00	1.24	1.24
	Running Exhaust	0.00	0.00	0.45	0.45
	Exhaust Start	0.00	0.00	0.17	0.17
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	0.62	0.62
CO	Total	0.00	0.00	3.33	3.33
	Running Exhaust	0.00	0.00	1.66	1.66
	Exhaust Start	0.00	0.00	0.50	0.50
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	1.17	1.17
NOx	Total	0.00	0.00	8.02	8.02
	Running Exhaust	0.00	0.00	5.27	5.27
	Exhaust Start	0.00	0.00	0.07	0.07
	Crankcase	0.00	0.00	0.00	0.00
	Hotelling/APU	0.00	0.00	2.68	2.68
PM2.5	Total	0.000	0.000	0.113	0.113
	Running Exhaust	0.000	0.000	0.063	0.063
	Exhaust Start	0.000	0.000	0.000	0.000
	Crankcase	0.000	0.000	0.039	0.039
	Hotelling/APU	0.000	0.000	0.011	0.011

Appendix B

Additional Sensitivity Scenario Inventory Results

Appendix B

Additional Sensitivity Scenario Inventory Results

Inventory Key	
Inventory Scenario	**Description**
Sensitivity Scenario 1	+1 PSI RVP change with Fuel Wizard relationships
Sensitivity Scenario 2	+1 PSI RVP change
Sensitivity Scenario 3	100% E10
Sensitivity Scenario 4	100% E15
Sensitivity Scenario 5	100% E15 with updated T50 relationship
Sensitivity Scenario 6	Add or remove I/M (relative to Base Case)
Sensitivity Scenario 7	Add startup NOx emissions for SCR equipped diesel trucks
Sensitivity Scenario 8	Add or remove reformulated gasoline (relative to Base Case)
Sensitivity Scenario 9	Change local passenger car and light truck mix to national average

Fulton County (GA) Sensitivity Scenario 1, +1 PSI RVP (Fuel Wizard):

- Table B-1: Emission Inventory (Tons per Average Day)
- Table B-2: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-3: Inventory Impact (%) Relative to Base Case

Fulton County (GA) Sensitivity Scenario 2, +1 PSI RVP:

- Table B-4: Emission Inventory (Tons per Average Day)
- Table B-5: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-6: Inventory Impact (%) Relative to Base Case

Fulton County (GA) Sensitivity Scenario 3, 100% E10:

- Table B-7: Emission Inventory (Tons per Average Day)
- Table B-8: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-9: Inventory Impact (%) Relative to Base Case

Fulton County (GA) Sensitivity Scenario 4, 100% E15:

- Table B-10: Emission Inventory (Tons per Average Day)
- Table B-11: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-12: Inventory Impact (%) Relative to Base Case
- Table B-13: Inventory Difference Relative to 100% E10 (Tons per Average Day)
- Table B-14: Inventory Impact (%) Relative to 100% E10

Fulton County (GA) Sensitivity Scenario 5, 100% E15 (T50 Update):

- Table B-15: Emission Inventory (Tons per Average Day)
- Table B-16: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-17: Inventory Impact (%) Relative to Base Case
- Table B-18: Inventory Difference Relative to 100% E10 (Tons per Average Day)
- Table B-19: Inventory Impact (%) Relative to 100% E10

Fulton County (GA) Sensitivity Scenario 6, Remove I/M:

- Table B-20: Emission Inventory (Tons per Average Day)
- Table B-21: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-22: Inventory Impact (%) Relative to Base Case

Fulton County (GA) Sensitivity Scenario 7, Add SCR Startup:

- Table B-23: Emission Inventory (Tons per Average Day)
- Table B-24: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-25: Inventory Impact (%) Relative to Base Case

Fulton County (GA) Sensitivity Scenario 8, Reformulated Gasoline:

- Table B-26: Emission Inventory (Tons per Average Day)
- Table B-27: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-28: Inventory Impact (%) Relative to Base Case

Fulton County (GA) Sensitivity Scenario 9, National PC/LDT Mix:

- Table B-29: Emission Inventory (Tons per Average Day)
- Table B-30: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-31: Inventory Impact (%) Relative to Base Case

Maricopa County (AZ) Sensitivity Scenario 1, +1 PSI RVP (Fuel Wizard):

- Table B-32: Emission Inventory (Tons per Average Day)
- Table B-33: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-34: Inventory Impact (%) Relative to Base Case

Maricopa County (AZ) Sensitivity Scenario 2, +1 PSI RVP:

- Table B-35: Emission Inventory (Tons per Average Day)
- Table B-36: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-37: Inventory Impact (%) Relative to Base Case

Maricopa County (AZ) Sensitivity Scenario 3, 100% E10: ***Not Modeled, Same as Base Case***

Maricopa County (AZ) Sensitivity Scenario 4, 100% E15:

- Table B-38: Emission Inventory (Tons per Average Day)
- Table B-39: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-40: Inventory Impact (%) Relative to Base Case

Maricopa County (AZ) Sensitivity Scenario 5, 100% E15 (T50 Update):

- Table B-41: Inventory Impact (%) Relative to Base Case
- Table B-42: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-43: Inventory Impact (%) Relative to Base Case

Maricopa County (AZ) Sensitivity Scenario 6, Remove I/M:

- Table B-44: Emission Inventory (Tons per Average Day)
- Table B-45: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-46: Inventory Impact (%) Relative to Base Case

Maricopa County (AZ) Sensitivity Scenario 7, Add SCR Startup:

- Table B-47: Emission Inventory (Tons per Average Day)
- Table B-48: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-49: Inventory Impact (%) Relative to Base Case

Maricopa County (AZ) Sensitivity Scenario 8, Conventional Gasoline:

- Table B-50: Emission Inventory (Tons per Average Day)
- Table B-51: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-52: Inventory Impact (%) Relative to Base Case

Maricopa County (AZ) Sensitivity Scenario 9, National PC/LDT Mix:

- Table B-53: Emission Inventory (Tons per Average Day)
- Table B-54: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-55: Inventory Impact (%) Relative to Base Case

Wayne County (MI) Sensitivity Scenario 1, +1 PSI RVP (Fuel Wizard):

- Table B-56: Emission Inventory (Tons per Average Day)
- Table B-57: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-58: Inventory Impact (%) Relative to Base Case

Wayne County (MI) Sensitivity Scenario 2, +1 PSI RVP:

- Table B-59: Emission Inventory (Tons per Average Day)
- Table B-60: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-61: Inventory Impact (%) Relative to Base Case

Wayne County (MI) Sensitivity Scenario 3, 100% E10:

- Table B-62: Emission Inventory (Tons per Average Day)
- Table B-63: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-64: Inventory Impact (%) Relative to Base Case

Wayne County (MI) Sensitivity Scenario 4, 100% E15:

- Table B-65: Emission Inventory (Tons per Average Day)
- Table B-66: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-67: Inventory Impact (%) Relative to Base Case
- Table B-68: Inventory Difference Relative to 100% E10 (Tons per Average Day)
- Table B-69: Inventory Impact (%) Relative to 100% E10

Wayne County (MI) Sensitivity Scenario 5, 100% E15 (T50 Update):

- Table B-70: Emission Inventory (Tons per Average Day)
- Table B-71: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-72: Inventory Impact (%) Relative to Base Case
- Table B-73: Inventory Difference Relative to 100% E10 (Tons per Average Day)
- Table B-74: Inventory Impact (%) Relative to 100% E10

Wayne County (MI) Sensitivity Scenario 6, Add I/M:

- Table B-75: Emission Inventory (Tons per Average Day)
- Table B-76: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-77: Inventory Impact (%) Relative to Base Case

Wayne County (MI) Sensitivity Scenario 7, Add SCR Startup:

- Table B-78: Emission Inventory (Tons per Average Day)
- Table B-79: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-80: Inventory Impact (%) Relative to Base Case

Wayne County (MI) Sensitivity Scenario 8, Reformulated Gasoline:

- Table B-81: Emission Inventory (Tons per Average Day)
- Table B-82: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-83: Inventory Impact (%) Relative to Base Case

Wayne County (MI) Sensitivity Scenario 9, National PC/LDT Mix:

- Table B-84: Emission Inventory (Tons per Average Day)
- Table B-85: Inventory Difference Relative to Base Case (Tons per Average Day)
- Table B-86: Inventory Impact (%) Relative to Base Case

Table B-1
Fulton County (GA) Sensitivity Scenario 1 Emission Inventory, +1 PSI RVP (Fuel Wizard) (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	11.948	6.596	0.856	0.242	0.109	0.142	0.191	1.192	0.040	0.177	21.492
2011	Summer	CO	233.418	0.000	20.577	0.000	1.554	0.000	3.585	6.177	0.067	0.291	265.668
2011	Summer	NOX	24.274	0.000	2.026	0.000	0.059	0.000	0.253	14.878	0.000	0.592	42.083
2011	Summer	PM2.5	0.252	0.000	0.013	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.131
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	3.548	3.583	0.255	0.125	0.084	0.165	0.050	0.379	0.006	0.146	8.340
2022	Summer	CO	134.499	0.000	11.406	0.000	1.272	0.000	1.714	2.327	0.010	0.272	151.498
2022	Summer	NOX	5.711	0.000	0.564	0.000	0.061	0.000	0.077	4.151	0.000	0.495	11.060
2022	Summer	PM2.5	0.204	0.000	0.010	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.376
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	1.065	2.206	0.125	0.106	0.110	0.223	0.017	0.290	0.000	0.160	4.303
2050	Summer	CO	58.374	0.000	6.232	0.000	1.656	0.000	0.834	2.078	0.000	0.306	69.480
2050	Summer	NOX	1.422	0.000	0.202	0.000	0.081	0.000	0.019	2.617	0.000	0.540	4.881
2050	Summer	PM2.5	0.143	0.000	0.013	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.216
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-2
Fulton County (GA) Sensitivity Scenario 1 Inventory Difference, +1 PSI RVP (Fuel Wizard) Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-0.174	0.280	-0.019	0.010	-0.003	0.011	0.000	0.000	0.000	0.000	0.105
2011	Summer	CO	1.390	0.000	0.135	0.000	0.014	0.000	0.000	0.000	0.000	0.000	1.539
2011	Summer	NOX	0.191	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200
2011	Summer	PM2.5	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.002
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	-0.129	0.081	-0.010	0.004	-0.003	0.012	0.000	0.000	0.000	0.000	-0.044
2022	Summer	CO	1.353	0.000	0.116	0.000	0.014	0.000	0.000	0.000	0.000	0.000	1.483
2022	Summer	NOX	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
2022	Summer	PM2.5	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.004
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	-0.049	0.017	-0.006	0.003	-0.004	0.017	0.000	0.000	0.000	0.000	-0.022
2050	Summer	CO	0.625	0.000	0.068	0.000	0.018	0.000	0.000	0.000	0.000	0.000	0.712
2050	Summer	NOX	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003
2050	Summer	PM2.5	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-3
Fulton County (GA) Sensitivity Scenario 1, Percent Inventory Impact, +1 PSI RVP (Fuel Wizard) Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-1.4%	4.4%	-2.1%	4.2%	-2.9%	8.2%	0.0%	0.0%	0.0%	0.0%	0.5%
2011	Summer	CO	0.6%	#N/A	0.7%	#N/A	0.9%	#N/A	0.0%	0.0%	0.0%	0.0%	0.6%
2011	Summer	NOX	0.8%	#N/A	0.4%	#N/A	0.3%	#N/A	0.0%	0.0%	#N/A	0.0%	0.5%
2011	Summer	PM2.5	-0.8%	#N/A	-0.7%	#N/A	-1.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.2%
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	-3.5%	2.3%	-3.7%	3.3%	-3.7%	8.0%	0.0%	0.0%	0.0%	0.0%	-0.5%
2022	Summer	CO	1.0%	#N/A	1.0%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Summer	NOX	0.2%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	0.1%
2022	Summer	PM2.5	-1.7%	#N/A	-1.5%	#N/A	-1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.0%
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	-4.4%	0.8%	-4.3%	3.2%	-3.6%	8.3%	0.0%	0.0%	0.0%	0.0%	-0.5%
2050	Summer	CO	1.1%	#N/A	1.1%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2050	Summer	NOX	-0.2%	#N/A	-0.1%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	-0.1%
2050	Summer	PM2.5	-1.8%	#N/A	-1.7%	#N/A	-1.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.3%
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-4
Fulton County (GA) Sensitivity Scenario 2 Emission Inventory, +1 PSI RVP (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	12.172	6.596	0.872	0.242	0.111	0.142	0.191	1.192	0.040	0.177	21.734
2011	Summer	CO	234.359	0.000	20.632	0.000	1.564	0.000	3.585	6.177	0.067	0.291	266.673
2011	Summer	NOX	24.284	0.000	2.027	0.000	0.059	0.000	0.253	14.878	0.000	0.592	42.094
2011	Summer	PM2.5	0.254	0.000	0.013	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.134
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	3.616	3.583	0.260	0.125	0.085	0.165	0.050	0.379	0.006	0.146	8.414
2022	Summer	CO	135.026	0.000	11.411	0.000	1.280	0.000	1.714	2.327	0.010	0.272	152.038
2022	Summer	NOX	5.718	0.000	0.565	0.000	0.061	0.000	0.077	4.151	0.000	0.495	11.067
2022	Summer	PM2.5	0.207	0.000	0.010	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.380
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	1.086	2.206	0.128	0.106	0.112	0.223	0.017	0.290	0.000	0.160	4.328
2050	Summer	CO	58.600	0.000	6.204	0.000	1.668	0.000	0.834	2.078	0.000	0.306	69.689
2050	Summer	NOX	1.425	0.000	0.202	0.000	0.081	0.000	0.019	2.617	0.000	0.540	4.884
2050	Summer	PM2.5	0.146	0.000	0.013	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.219
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-5
Fulton County (GA) Sensitivity Scenario 2 Inventory Difference, +1 PSI RVP Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.050	0.280	-0.003	0.010	-0.001	0.011	0.000	0.000	0.000	0.000	0.347
2011	Summer	CO	2.331	0.000	0.190	0.000	0.024	0.000	0.000	0.000	0.000	0.000	2.545
2011	Summer	NOX	0.202	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.211
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	-0.061	0.081	-0.005	0.004	-0.002	0.012	0.000	0.000	0.000	0.000	0.030
2022	Summer	CO	1.880	0.000	0.121	0.000	0.023	0.000	0.000	0.000	0.000	0.000	2.023
2022	Summer	NOX	0.019	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	-0.028	0.017	-0.003	0.003	-0.003	0.017	0.000	0.000	0.000	0.000	0.003
2050	Summer	CO	0.851	0.000	0.040	0.000	0.029	0.000	0.000	0.000	0.000	0.000	0.921
2050	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-6
Fulton County (GA) Sensitivity Scenario 2, Percent Inventory Impact, +1 PSI RVP Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.4%	4.4%	-0.3%	4.2%	-1.2%	8.2%	0.0%	0.0%	0.0%	0.0%	1.6%
2011	Summer	CO	1.0%	#N/A	0.9%	#N/A	1.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2011	Summer	NOX	0.8%	#N/A	0.5%	#N/A	0.3%	#N/A	0.0%	0.0%	#N/A	0.0%	0.5%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	-1.6%	2.3%	-1.9%	3.3%	-2.2%	8.0%	0.0%	0.0%	0.0%	0.0%	0.4%
2022	Summer	CO	1.4%	#N/A	1.1%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.3%
2022	Summer	NOX	0.3%	#N/A	0.1%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	0.2%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	-2.5%	0.8%	-2.5%	3.2%	-2.2%	8.3%	0.0%	0.0%	0.0%	0.0%	0.1%
2050	Summer	CO	1.5%	#N/A	0.7%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.3%
2050	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	0.0%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-7
Fulton County (GA) Sensitivity Scenario 3 Emission Inventory, 100% E10 (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	12.135	6.399	0.875	0.235	0.112	0.131	0.191	1.192	0.040	0.177	21.487
2011	Summer	CO	229.914	0.000	20.257	0.000	1.533	0.000	3.585	6.177	0.067	0.291	261.824
2011	Summer	NOX	24.242	0.000	2.031	0.000	0.060	0.000	0.253	14.878	0.000	0.592	42.056
2011	Summer	PM2.5	0.255	0.000	0.013	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.135
2011	Winter	THC	14.624	3.189	0.768	0.121	0.053	0.058	0.194	1.146	0.038	0.167	20.356
2011	Winter	CO	185.629	0.000	16.986	0.000	0.745	0.000	2.277	5.192	0.058	0.274	211.161
2011	Winter	NOX	24.546	0.000	2.106	0.000	0.038	0.000	0.225	16.887	0.000	0.716	44.518
2011	Winter	PM2.5	0.537	0.000	0.028	0.000	0.002	0.000	0.003	0.608	0.152	0.009	1.339
2022	Summer	THC	3.672	3.508	0.265	0.121	0.087	0.154	0.050	0.379	0.006	0.146	8.387
2022	Summer	CO	133.804	0.000	11.341	0.000	1.264	0.000	1.714	2.327	0.010	0.272	150.730
2022	Summer	NOX	5.680	0.000	0.562	0.000	0.061	0.000	0.077	4.151	0.000	0.495	11.026
2022	Summer	PM2.5	0.207	0.000	0.010	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.379
2022	Winter	THC	5.254	2.009	0.248	0.073	0.038	0.068	0.089	0.472	0.006	0.137	8.393
2022	Winter	CO	95.775	0.000	8.884	0.000	0.584	0.000	0.994	2.014	0.009	0.256	108.516
2022	Winter	NOX	6.287	0.000	0.577	0.000	0.039	0.000	0.068	4.647	0.000	0.598	12.216
2022	Winter	PM2.5	0.257	0.000	0.012	0.000	0.001	0.000	0.002	0.105	0.033	0.003	0.412
2050	Summer	THC	1.114	2.191	0.131	0.103	0.114	0.210	0.017	0.290	0.000	0.160	4.331
2050	Summer	CO	58.281	0.000	6.208	0.000	1.655	0.000	0.834	2.078	0.000	0.306	69.362
2050	Summer	NOX	1.418	0.000	0.201	0.000	0.080	0.000	0.019	2.617	0.000	0.540	4.875
2050	Summer	PM2.5	0.145	0.000	0.013	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.218
2050	Winter	THC	3.386	1.588	0.143	0.074	0.051	0.094	0.084	0.454	0.000	0.151	6.025
2050	Winter	CO	50.771	0.000	5.811	0.000	0.766	0.000	0.487	1.874	0.000	0.288	59.997
2050	Winter	NOX	2.550	0.000	0.235	0.000	0.051	0.000	0.018	2.973	0.000	0.653	6.481
2050	Winter	PM2.5	0.147	0.000	0.012	0.000	0.001	0.000	0.001	0.034	0.008	0.003	0.206

Table B-8
Fulton County (GA) Sensitivity Scenario 3 Inventory Difference, 100% E10 Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.013	0.083	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.100
2011	Summer	CO	-2.114	0.000	-0.184	0.000	-0.007	0.000	0.000	0.000	0.000	0.000	-2.305
2011	Summer	NOX	0.160	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.173
2011	Summer	PM2.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
2011	Winter	THC	-0.032	0.014	-0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	-0.019
2011	Winter	CO	-1.402	0.000	-0.134	0.000	-0.004	0.000	0.000	0.000	0.000	0.000	-1.540
2011	Winter	NOX	0.151	0.000	0.012	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.163
2011	Winter	PM2.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001
2022	Summer	THC	-0.005	0.006	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.003
2022	Summer	CO	0.657	0.000	0.051	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.715
2022	Summer	NOX	-0.019	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.022
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC	-0.012	0.002	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.011
2022	Winter	CO	0.491	0.000	0.043	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.537
2022	Winter	NOX	-0.019	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.021
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	THC	0.000	0.001	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.006
2050	Summer	CO	0.532	0.000	0.044	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.594
2050	Summer	NOX	-0.007	0.000	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.009
2050	Summer	PM2.5	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001
2050	Winter	THC	-0.005	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	-0.004
2050	Winter	CO	0.365	0.000	0.035	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.409
2050	Winter	NOX	-0.008	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.010
2050	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B-9
Fulton County (GA) Sensitivity Scenario 3, Percent Inventory Impact, 100% E10 Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.1%	1.3%	0.0%	1.3%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.5%
2011	Summer	CO	-0.9%	#N/A	-0.9%	#N/A	-0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.9%
2011	Summer	NOX	0.7%	#N/A	0.6%	#N/A	0.6%	#N/A	0.0%	0.0%	#N/A	0.0%	0.4%
2011	Summer	PM2.5	0.3%	#N/A	0.3%	#N/A	0.7%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2011	Winter	THC	-0.2%	0.4%	-0.2%	0.6%	-0.1%	-0.7%	0.0%	0.0%	0.0%	0.0%	-0.1%
2011	Winter	CO	-0.7%	#N/A	-0.8%	#N/A	-0.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.7%
2011	Winter	NOX	0.6%	#N/A	0.6%	#N/A	0.6%	#N/A	0.0%	0.0%	#N/A	0.0%	0.4%
2011	Winter	PM2.5	0.1%	#N/A	0.1%	#N/A	0.3%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	THC	-0.1%	0.2%	-0.1%	0.2%	0.0%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	CO	0.5%	#N/A	0.5%	#N/A	0.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2022	Summer	NOX	-0.3%	#N/A	-0.3%	#N/A	-0.4%	#N/A	0.0%	0.0%	#N/A	0.0%	-0.2%
2022	Summer	PM2.5	-0.2%	#N/A	-0.3%	#N/A	-0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2022	Winter	THC	-0.2%	0.1%	-0.3%	0.1%	-0.3%	0.5%	0.0%	0.0%	0.0%	0.0%	-0.1%
2022	Winter	CO	0.5%	#N/A	0.5%	#N/A	0.6%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2022	Winter	NOX	-0.3%	#N/A	-0.3%	#N/A	-0.3%	#N/A	0.0%	0.0%	#N/A	0.0%	-0.2%
2022	Winter	PM2.5	-0.1%	#N/A	-0.2%	#N/A	-0.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2050	Summer	THC	0.0%	0.1%	0.0%	0.5%	-0.1%	1.7%	0.0%	0.0%	0.0%	0.0%	0.1%
2050	Summer	CO	0.9%	#N/A	0.7%	#N/A	1.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.9%
2050	Summer	NOX	-0.5%	#N/A	-0.7%	#N/A	-0.8%	#N/A	0.0%	0.0%	#N/A	0.0%	-0.2%
2050	Summer	PM2.5	-0.4%	#N/A	-0.5%	#N/A	-0.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.3%
2050	Winter	THC	-0.1%	0.0%	-0.3%	0.2%	-0.5%	1.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
2050	Winter	CO	0.7%	#N/A	0.6%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.7%
2050	Winter	NOX	-0.3%	#N/A	-0.6%	#N/A	-0.7%	#N/A	0.0%	0.0%	#N/A	0.0%	-0.2%
2050	Winter	PM2.5	-0.3%	#N/A	-0.3%	#N/A	-0.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.2%

Table B-10
Fulton County (GA) Sensitivity Scenario 4 Emission Inventory, 100% E15 (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	12.561	6.228	0.897	0.230	0.114	0.123	0.191	1.192	0.040	0.177	21.751
2011	Summer	CO	218.219	0.000	19.297	0.000	1.458	0.000	3.585	6.177	0.067	0.291	249.092
2011	Summer	NOX	25.057	0.000	2.098	0.000	0.062	0.000	0.253	14.878	0.000	0.592	42.941
2011	Summer	PM2.5	0.257	0.000	0.014	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.137
2011	Winter	THC	15.408	3.148	0.808	0.119	0.055	0.055	0.194	1.146	0.038	0.167	21.138
2011	Winter	CO	168.661	0.000	15.563	0.000	0.691	0.000	2.277	5.192	0.058	0.274	192.716
2011	Winter	NOX	25.411	0.000	2.176	0.000	0.039	0.000	0.225	16.887	0.000	0.716	45.454
2011	Winter	PM2.5	0.540	0.000	0.028	0.000	0.002	0.000	0.003	0.608	0.152	0.009	1.342
2022	Summer	THC	3.712	3.460	0.267	0.119	0.087	0.145	0.050	0.379	0.006	0.146	8.369
2022	Summer	CO	128.120	0.000	10.898	0.000	1.207	0.000	1.714	2.327	0.010	0.272	144.546
2022	Summer	NOX	5.847	0.000	0.579	0.000	0.063	0.000	0.077	4.151	0.000	0.495	11.212
2022	Summer	PM2.5	0.211	0.000	0.011	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.384
2022	Winter	THC	5.356	1.997	0.254	0.072	0.039	0.065	0.089	0.472	0.006	0.137	8.486
2022	Winter	CO	91.530	0.000	8.510	0.000	0.556	0.000	0.994	2.014	0.009	0.256	103.869
2022	Winter	NOX	6.450	0.000	0.593	0.000	0.040	0.000	0.068	4.647	0.000	0.598	12.395
2022	Winter	PM2.5	0.259	0.000	0.012	0.000	0.001	0.000	0.002	0.105	0.033	0.003	0.415
2050	Summer	THC	1.113	2.185	0.131	0.101	0.115	0.196	0.017	0.290	0.000	0.160	4.308
2050	Summer	CO	55.884	0.000	6.008	0.000	1.580	0.000	0.834	2.078	0.000	0.306	66.690
2050	Summer	NOX	1.450	0.000	0.207	0.000	0.083	0.000	0.019	2.617	0.000	0.540	4.916
2050	Summer	PM2.5	0.148	0.000	0.013	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.222
2050	Winter	THC	3.407	1.588	0.145	0.073	0.053	0.090	0.084	0.454	0.000	0.151	6.044
2050	Winter	CO	49.126	0.000	5.651	0.000	0.730	0.000	0.487	1.874	0.000	0.288	58.156
2050	Winter	NOX	2.588	0.000	0.241	0.000	0.053	0.000	0.018	2.973	0.000	0.653	6.526
2050	Winter	PM2.5	0.148	0.000	0.012	0.000	0.002	0.000	0.001	0.034	0.008	0.003	0.208

Table B-11
Fulton County (GA) Sensitivity Scenario 4 Inventory Difference, 100% E15 Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.439	-0.088	0.022	-0.002	0.001	-0.008	0.000	0.000	0.000	0.000	0.364
2011	Summer	CO	-13.809	0.000	-1.145	0.000	-0.082	0.000	0.000	0.000	0.000	0.000	-15.036
2011	Summer	NOX	0.975	0.000	0.080	0.000	0.002	0.000	0.000	0.000	0.000	0.000	1.058
2011	Summer	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
2011	Winter	THC	0.752	-0.027	0.038	-0.001	0.002	-0.003	0.000	0.000	0.000	0.000	0.762
2011	Winter	CO	-18.370	0.000	-1.557	0.000	-0.058	0.000	0.000	0.000	0.000	0.000	-19.984
2011	Winter	NOX	1.016	0.000	0.082	0.000	0.001	0.000	0.000	0.000	0.000	0.000	1.100
2011	Winter	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
2022	Summer	THC	0.035	-0.042	0.002	-0.002	0.000	-0.009	0.000	0.000	0.000	0.000	-0.015
2022	Summer	CO	-5.027	0.000	-0.392	0.000	-0.051	0.000	0.000	0.000	0.000	0.000	-5.469
2022	Summer	NOX	0.148	0.000	0.015	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.165
2022	Summer	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
2022	Winter	THC	0.090	-0.011	0.005	-0.001	0.001	-0.002	0.000	0.000	0.000	0.000	0.082
2022	Winter	CO	-3.753	0.000	-0.331	0.000	-0.025	0.000	0.000	0.000	0.000	0.000	-4.109
2022	Winter	NOX	0.144	0.000	0.014	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.159
2022	Winter	PM2.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2050	Summer	THC	-0.001	-0.004	0.000	-0.001	0.000	-0.011	0.000	0.000	0.000	0.000	-0.017
2050	Summer	CO	-1.864	0.000	-0.156	0.000	-0.059	0.000	0.000	0.000	0.000	0.000	-2.078
2050	Summer	NOX	0.026	0.000	0.005	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.032
2050	Summer	PM2.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2050	Winter	THC	0.016	0.000	0.001	-0.001	0.001	-0.003	0.000	0.000	0.000	0.000	0.015
2050	Winter	CO	-1.280	0.000	-0.124	0.000	-0.028	0.000	0.000	0.000	0.000	0.000	-1.432
2050	Winter	NOX	0.029	0.000	0.005	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.035
2050	Winter	PM2.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002

Table B-12
Fulton County (GA) Sensitivity Scenario 4, Percent Inventory Impact, 100% E15 Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	3.6%	-1.4%	2.5%	-0.8%	1.2%	-6.1%	0.0%	0.0%	0.0%	0.0%	1.7%
2011	Summer	CO	-6.0%	#N/A	-5.6%	#N/A	-5.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.7%
2011	Summer	NOX	4.0%	#N/A	4.0%	#N/A	4.1%	#N/A	0.0%	0.0%	#N/A	0.0%	2.5%
2011	Summer	PM2.5	1.3%	#N/A	1.5%	#N/A	3.6%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Winter	THC	5.1%	-0.8%	5.0%	-0.6%	4.2%	-4.6%	0.0%	0.0%	0.0%	0.0%	3.7%
2011	Winter	CO	-9.8%	#N/A	-9.1%	#N/A	-7.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-9.4%
2011	Winter	NOX	4.2%	#N/A	3.9%	#N/A	3.8%	#N/A	0.0%	0.0%	#N/A	0.0%	2.5%
2011	Winter	PM2.5	0.7%	#N/A	0.7%	#N/A	1.9%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2022	Summer	THC	1.0%	-1.2%	0.7%	-1.4%	0.3%	-5.6%	0.0%	0.0%	0.0%	0.0%	-0.2%
2022	Summer	CO	-3.8%	#N/A	-3.5%	#N/A	-4.1%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.6%
2022	Summer	NOX	2.6%	#N/A	2.7%	#N/A	3.0%	#N/A	0.0%	0.0%	#N/A	0.0%	1.5%
2022	Summer	PM2.5	1.7%	#N/A	2.1%	#N/A	3.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Winter	THC	1.7%	-0.6%	2.1%	-0.8%	2.1%	-3.4%	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Winter	CO	-3.9%	#N/A	-3.7%	#N/A	-4.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.8%
2022	Winter	NOX	2.3%	#N/A	2.4%	#N/A	2.6%	#N/A	0.0%	0.0%	#N/A	0.0%	1.3%
2022	Winter	PM2.5	0.9%	#N/A	1.2%	#N/A	2.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.6%
2050	Summer	THC	-0.1%	-0.2%	0.0%	-1.5%	0.3%	-5.1%	0.0%	0.0%	0.0%	0.0%	-0.4%
2050	Summer	CO	-3.2%	#N/A	-2.5%	#N/A	-3.6%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.0%
2050	Summer	NOX	1.8%	#N/A	2.3%	#N/A	2.6%	#N/A	0.0%	0.0%	#N/A	0.0%	0.7%
2050	Summer	PM2.5	1.5%	#N/A	1.9%	#N/A	2.7%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%
2050	Winter	THC	0.5%	0.0%	0.9%	-0.8%	1.8%	-3.2%	0.0%	0.0%	0.0%	0.0%	0.2%
2050	Winter	CO	-2.5%	#N/A	-2.1%	#N/A	-3.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.4%
2050	Winter	NOX	1.1%	#N/A	2.0%	#N/A	2.3%	#N/A	0.0%	0.0%	#N/A	0.0%	0.5%
2050	Winter	PM2.5	0.9%	#N/A	1.2%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	0.7%

Table B-13
Fulton County (GA) Sensitivity Scenario 4 Inventory Difference, 100% E15 Minus 100% E10 (Tons per Average Day)

Year	Season	Pollutant	Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			Total On-Road
			Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	
2011	Summer	THC	0.426	-0.171	0.022	-0.005	0.001	-0.008	0.000	0.000	0.000	0.000	0.264
2011	Summer	CO	-11.695	0.000	-0.961	0.000	-0.076	0.000	0.000	0.000	0.000	0.000	-12.731
2011	Summer	NOX	0.816	0.000	0.067	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.885
2011	Summer	PM2.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2011	Winter	THC	0.784	-0.040	0.040	-0.002	0.002	-0.002	0.000	0.000	0.000	0.000	0.782
2011	Winter	CO	-16.968	0.000	-1.422	0.000	-0.054	0.000	0.000	0.000	0.000	0.000	-18.444
2011	Winter	NOX	0.865	0.000	0.070	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.936
2011	Winter	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2022	Summer	THC	0.040	-0.048	0.002	-0.002	0.000	-0.010	0.000	0.000	0.000	0.000	-0.018
2022	Summer	CO	-5.684	0.000	-0.443	0.000	-0.058	0.000	0.000	0.000	0.000	0.000	-6.185
2022	Summer	NOX	0.167	0.000	0.017	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.186
2022	Summer	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
2022	Winter	THC	0.102	-0.013	0.006	-0.001	0.001	-0.003	0.000	0.000	0.000	0.000	0.093
2022	Winter	CO	-4.244	0.000	-0.374	0.000	-0.028	0.000	0.000	0.000	0.000	0.000	-4.647
2022	Winter	NOX	0.163	0.000	0.016	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.180
2022	Winter	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2050	Summer	THC	-0.001	-0.006	0.000	-0.002	0.000	-0.014	0.000	0.000	0.000	0.000	-0.023
2050	Summer	CO	-2.396	0.000	-0.200	0.000	-0.075	0.000	0.000	0.000	0.000	0.000	-2.672
2050	Summer	NOX	0.033	0.000	0.006	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.042
2050	Summer	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2050	Winter	THC	0.021	0.000	0.002	-0.001	0.001	-0.004	0.000	0.000	0.000	0.000	0.019
2050	Winter	CO	-1.645	0.000	-0.160	0.000	-0.036	0.000	0.000	0.000	0.000	0.000	-1.841
2050	Winter	NOX	0.038	0.000	0.006	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.045
2050	Winter	PM2.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002

Table B-14
Fulton County (GA) Sensitivity Scenario 4, Percent Inventory Impact, 100% E15 Relative to 100% E10 (%)

Year	Season	Pollutant	Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			Total On-Road
			Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	
2011	Summer	THC	3.5%	-2.7%	2.5%	-2.2%	1.2%	-6.2%	0.0%	0.0%	0.0%	0.0%	1.2%
2011	Summer	CO	-5.1%	#N/A	-4.7%	#N/A	-4.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.9%
2011	Summer	NOX	3.4%	#N/A	3.3%	#N/A	3.5%	#N/A	0.0%	0.0%	#N/A	0.0%	2.1%
2011	Summer	PM2.5	0.9%	#N/A	1.2%	#N/A	2.9%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2011	Winter	THC	5.4%	-1.3%	5.2%	-1.2%	4.3%	-3.9%	0.0%	0.0%	0.0%	0.0%	3.8%
2011	Winter	CO	-9.1%	#N/A	-8.4%	#N/A	-7.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.7%
2011	Winter	NOX	3.5%	#N/A	3.3%	#N/A	3.2%	#N/A	0.0%	0.0%	#N/A	0.0%	2.1%
2011	Winter	PM2.5	0.6%	#N/A	0.6%	#N/A	1.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2022	Summer	THC	1.1%	-1.4%	0.8%	-1.7%	0.4%	-6.3%	0.0%	0.0%	0.0%	0.0%	-0.2%
2022	Summer	CO	-4.2%	#N/A	-3.9%	#N/A	-4.6%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.1%
2022	Summer	NOX	2.9%	#N/A	3.0%	#N/A	3.4%	#N/A	0.0%	0.0%	#N/A	0.0%	1.7%
2022	Summer	PM2.5	1.9%	#N/A	2.4%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2022	Winter	THC	1.9%	-0.6%	2.3%	-1.0%	2.3%	-3.9%	0.0%	0.0%	0.0%	0.0%	1.1%
2022	Winter	CO	-4.4%	#N/A	-4.2%	#N/A	-4.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.3%
2022	Winter	NOX	2.6%	#N/A	2.8%	#N/A	3.0%	#N/A	0.0%	0.0%	#N/A	0.0%	1.5%
2022	Winter	PM2.5	1.0%	#N/A	1.4%	#N/A	2.4%	#N/A	0.0%	0.0%	0.0%	0.0%	0.7%
2050	Summer	THC	-0.1%	-0.3%	0.0%	-1.9%	0.3%	-6.7%	0.0%	0.0%	0.0%	0.0%	-0.5%
2050	Summer	CO	-4.1%	#N/A	-3.2%	#N/A	-4.6%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.9%
2050	Summer	NOX	2.3%	#N/A	3.0%	#N/A	3.4%	#N/A	0.0%	0.0%	#N/A	0.0%	0.9%
2050	Summer	PM2.5	1.9%	#N/A	2.5%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.5%
2050	Winter	THC	0.6%	0.0%	1.1%	-1.0%	2.3%	-4.2%	0.0%	0.0%	0.0%	0.0%	0.3%
2050	Winter	CO	-3.2%	#N/A	-2.7%	#N/A	-4.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.1%
2050	Winter	NOX	1.5%	#N/A	2.5%	#N/A	3.0%	#N/A	0.0%	0.0%	#N/A	0.0%	0.7%
2050	Winter	PM2.5	1.2%	#N/A	1.6%	#N/A	2.4%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%

Table B-15
Fulton County (GA) Sensitivity Scenario 5 Emission Inventory, 100% E15 (T50 Update) (Tons per Average Day)

Year	Season	Pollutant	Light-Duty Gasoline Exhaust	Light-Duty Gasoline Evap.	Heavy-Duty Gasoline Exhaust	Heavy-Duty Gasoline Evap.	Motorcycle Exhaust	Motorcycle Evap.	Light-Duty Diesel Exhaust	Heavy-Duty Diesel Exhaust	Heavy-Duty Diesel Crank Case	Heavy-Duty Diesel Idling / APU	Total On-Road
2011	Summer	THC	12.483	6.228	0.883	0.230	0.112	0.123	0.191	1.192	0.040	0.177	21.657
2011	Summer	CO	217.441	0.000	19.176	0.000	1.437	0.000	3.585	6.177	0.067	0.291	248.173
2011	Summer	NOX	25.187	0.000	2.101	0.000	0.062	0.000	0.253	14.878	0.000	0.592	43.073
2011	Summer	PM2.5	0.257	0.000	0.014	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.137
2011	Winter	THC	15.744	3.148	0.824	0.119	0.056	0.055	0.194	1.146	0.038	0.167	21.490
2011	Winter	CO	170.134	0.000	15.688	0.000	0.691	0.000	2.277	5.192	0.058	0.274	194.313
2011	Winter	NOX	25.511	0.000	2.181	0.000	0.039	0.000	0.225	16.887	0.000	0.716	45.559
2011	Winter	PM2.5	0.543	0.000	0.028	0.000	0.002	0.000	0.003	0.608	0.152	0.009	1.344
2022	Summer	THC	3.543	3.460	0.256	0.119	0.085	0.145	0.050	0.379	0.006	0.146	8.187
2022	Summer	CO	126.075	0.000	10.744	0.000	1.182	0.000	1.714	2.327	0.010	0.272	142.323
2022	Summer	NOX	5.804	0.000	0.575	0.000	0.063	0.000	0.077	4.151	0.000	0.495	11.164
2022	Summer	PM2.5	0.211	0.000	0.011	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.384
2022	Winter	THC	5.345	1.997	0.254	0.072	0.039	0.065	0.089	0.472	0.006	0.137	8.476
2022	Winter	CO	91.810	0.000	8.558	0.000	0.552	0.000	0.994	2.014	0.009	0.256	104.193
2022	Winter	NOX	6.417	0.000	0.591	0.000	0.040	0.000	0.068	4.647	0.000	0.598	12.361
2022	Winter	PM2.5	0.263	0.000	0.012	0.000	0.001	0.000	0.002	0.105	0.033	0.003	0.419
2050	Summer	THC	1.040	2.185	0.124	0.101	0.112	0.196	0.017	0.290	0.000	0.160	4.225
2050	Summer	CO	54.883	0.000	5.930	0.000	1.548	0.000	0.834	2.078	0.000	0.306	65.579
2050	Summer	NOX	1.424	0.000	0.205	0.000	0.083	0.000	0.019	2.617	0.000	0.540	4.888
2050	Summer	PM2.5	0.149	0.000	0.013	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.222
2050	Winter	THC	3.374	1.588	0.144	0.073	0.053	0.090	0.084	0.454	0.000	0.151	6.010
2050	Winter	CO	49.403	0.000	5.710	0.000	0.726	0.000	0.487	1.874	0.000	0.288	58.488
2050	Winter	NOX	2.554	0.000	0.240	0.000	0.053	0.000	0.018	2.973	0.000	0.653	6.491
2050	Winter	PM2.5	0.151	0.000	0.012	0.000	0.002	0.000	0.001	0.034	0.008	0.003	0.211

Table B-16
Fulton County (GA) Sensitivity Scenario 5 Inventory Difference, 100% E15 (T50 Update) Minus Base Case (Tons per Average Day)

Year	Season	Pollutant	Light-Duty Gasoline Exhaust	Light-Duty Gasoline Evap.	Heavy-Duty Gasoline Exhaust	Heavy-Duty Gasoline Evap.	Motorcycle Exhaust	Motorcycle Evap.	Light-Duty Diesel Exhaust	Heavy-Duty Diesel Exhaust	Heavy-Duty Diesel Crank Case	Heavy-Duty Diesel Idling / APU	Total On-Road
2011	Summer	THC	0.361	-0.088	0.008	-0.002	-0.001	-0.008	0.000	0.000	0.000	0.000	0.270
2011	Summer	CO	-14.587	0.000	-1.266	0.000	-0.103	0.000	0.000	0.000	0.000	0.000	-15.955
2011	Summer	NOX	1.104	0.000	0.083	0.000	0.003	0.000	0.000	0.000	0.000	0.000	1.190
2011	Summer	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
2011	Winter	THC	1.087	-0.027	0.054	-0.001	0.003	-0.003	0.000	0.000	0.000	0.000	1.115
2011	Winter	CO	-16.897	0.000	-1.432	0.000	-0.058	0.000	0.000	0.000	0.000	0.000	-18.387
2011	Winter	NOX	1.117	0.000	0.087	0.000	0.001	0.000	0.000	0.000	0.000	0.000	1.205
2011	Winter	PM2.5	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006
2022	Summer	THC	-0.134	-0.042	-0.009	-0.002	-0.002	-0.009	0.000	0.000	0.000	0.000	-0.197
2022	Summer	CO	-7.071	0.000	-0.545	0.000	-0.075	0.000	0.000	0.000	0.000	0.000	-7.692
2022	Summer	NOX	0.104	0.000	0.011	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.117
2022	Summer	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
2022	Winter	THC	0.080	-0.011	0.005	-0.001	0.001	-0.002	0.000	0.000	0.000	0.000	0.072
2022	Winter	CO	-3.474	0.000	-0.283	0.000	-0.028	0.000	0.000	0.000	0.000	0.000	-3.785
2022	Winter	NOX	0.111	0.000	0.012	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.124
2022	Winter	PM2.5	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006
2050	Summer	THC	-0.074	-0.004	-0.008	-0.001	-0.003	-0.011	0.000	0.000	0.000	0.000	-0.100
2050	Summer	CO	-2.865	0.000	-0.234	0.000	-0.091	0.000	0.000	0.000	0.000	0.000	-3.189
2050	Summer	NOX	-0.001	0.000	0.003	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.004
2050	Summer	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2050	Winter	THC	-0.017	0.000	0.000	-0.001	0.001	-0.003	0.000	0.000	0.000	0.000	-0.019
2050	Winter	CO	-1.002	0.000	-0.065	0.000	-0.033	0.000	0.000	0.000	0.000	0.000	-1.100
2050	Winter	NOX	-0.004	0.000	0.003	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005

Table B-17
Fulton County (GA) Sensitivity Scenario 5, Percent Inventory Impact, 100% E15 (T50 Update) Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	3.0%	-1.4%	0.9%	-0.8%	-0.6%	-6.1%	0.0%	0.0%	0.0%	0.0%	1.3%
2011	Summer	CO	-6.3%	#N/A	-6.2%	#N/A	-6.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-6.0%
2011	Summer	NOX	4.6%	#N/A	4.1%	#N/A	4.3%	#N/A	0.0%	0.0%	#N/A	0.0%	2.8%
2011	Summer	PM2.5	1.3%	#N/A	1.5%	#N/A	3.6%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Winter	THC	7.4%	-0.8%	7.1%	-0.6%	5.6%	-4.6%	0.0%	0.0%	0.0%	0.0%	5.5%
2011	Winter	CO	-9.0%	#N/A	-8.4%	#N/A	-7.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.6%
2011	Winter	NOX	4.6%	#N/A	4.1%	#N/A	4.0%	#N/A	0.0%	0.0%	#N/A	0.0%	2.7%
2011	Winter	PM2.5	1.1%	#N/A	0.9%	#N/A	2.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2022	Summer	THC	-3.6%	-1.2%	-3.4%	-1.4%	-2.1%	-5.6%	0.0%	0.0%	0.0%	0.0%	-2.3%
2022	Summer	CO	-5.3%	#N/A	-4.8%	#N/A	-6.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.1%
2022	Summer	NOX	1.8%	#N/A	1.9%	#N/A	3.0%	#N/A	0.0%	0.0%	#N/A	0.0%	1.1%
2022	Summer	PM2.5	1.9%	#N/A	2.3%	#N/A	3.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2022	Winter	THC	1.5%	-0.6%	2.1%	-0.8%	2.1%	-3.4%	0.0%	0.0%	0.0%	0.0%	0.9%
2022	Winter	CO	-3.6%	#N/A	-3.2%	#N/A	-4.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.5%
2022	Winter	NOX	1.8%	#N/A	2.1%	#N/A	2.5%	#N/A	0.0%	0.0%	#N/A	0.0%	1.0%
2022	Winter	PM2.5	2.4%	#N/A	2.3%	#N/A	2.4%	#N/A	0.0%	0.0%	0.0%	0.0%	1.6%
2050	Summer	THC	-6.7%	-0.2%	-5.7%	-1.5%	-2.2%	-5.1%	0.0%	0.0%	0.0%	0.0%	-2.3%
2050	Summer	CO	-5.0%	#N/A	-3.8%	#N/A	-5.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.6%
2050	Summer	NOX	-0.1%	#N/A	1.5%	#N/A	2.6%	#N/A	0.0%	0.0%	#N/A	0.0%	0.1%
2050	Summer	PM2.5	1.8%	#N/A	2.1%	#N/A	2.7%	#N/A	0.0%	0.0%	0.0%	0.0%	1.3%
2050	Winter	THC	-0.5%	0.0%	0.2%	-0.8%	1.8%	-3.2%	0.0%	0.0%	0.0%	0.0%	-0.3%
2050	Winter	CO	-2.0%	#N/A	-1.1%	#N/A	-4.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.8%
2050	Winter	NOX	-0.2%	#N/A	1.5%	#N/A	2.1%	#N/A	0.0%	0.0%	#N/A	0.0%	0.0%
2050	Winter	PM2.5	2.8%	#N/A	2.7%	#N/A	2.1%	#N/A	0.0%	0.0%	0.0%	0.0%	2.2%

Table B-18
Fulton County (GA) Sensitivity Scenario 5 Inventory Difference, 100% E15 (T50 Update) Minus 100% E10 (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.348	-0.171	0.008	-0.005	-0.001	-0.008	0.000	0.000	0.000	0.000	0.170
2011	Summer	CO	-12.473	0.000	-1.081	0.000	-0.097	0.000	0.000	0.000	0.000	0.000	-13.650
2011	Summer	NOX	0.945	0.000	0.071	0.000	0.002	0.000	0.000	0.000	0.000	0.000	1.018
2011	Summer	PM2.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2011	Winter	THC	1.120	-0.040	0.056	-0.002	0.003	-0.002	0.000	0.000	0.000	0.000	1.134
2011	Winter	CO	-15.495	0.000	-1.298	0.000	-0.054	0.000	0.000	0.000	0.000	0.000	-16.847
2011	Winter	NOX	0.966	0.000	0.074	0.000	0.001	0.000	0.000	0.000	0.000	0.000	1.042
2011	Winter	PM2.5	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
2022	Summer	THC	-0.129	-0.048	-0.009	-0.002	-0.002	-0.010	0.000	0.000	0.000	0.000	-0.200
2022	Summer	CO	-7.728	0.000	-0.597	0.000	-0.082	0.000	0.000	0.000	0.000	0.000	-8.407
2022	Summer	NOX	0.123	0.000	0.013	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.138
2022	Summer	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
2022	Winter	THC	0.092	-0.013	0.006	-0.001	0.001	-0.003	0.000	0.000	0.000	0.000	0.082
2022	Winter	CO	-3.965	0.000	-0.326	0.000	-0.031	0.000	0.000	0.000	0.000	0.000	-4.322
2022	Winter	NOX	0.130	0.000	0.014	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.145
2022	Winter	PM2.5	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
2050	Summer	THC	-0.074	-0.006	-0.008	-0.002	-0.002	-0.014	0.000	0.000	0.000	0.000	-0.106
2050	Summer	CO	-3.398	0.000	-0.278	0.000	-0.107	0.000	0.000	0.000	0.000	0.000	-3.783
2050	Summer	NOX	0.006	0.000	0.004	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.013
2050	Summer	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
2050	Winter	THC	-0.012	0.000	0.001	-0.001	0.001	-0.004	0.000	0.000	0.000	0.000	-0.015
2050	Winter	CO	-1.368	0.000	-0.101	0.000	-0.041	0.000	0.000	0.000	0.000	0.000	-1.509
2050	Winter	NOX	0.004	0.000	0.005	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.010
2050	Winter	PM2.5	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005

Table B-19
Fulton County (GA) Sensitivity Scenario 5, Percent Inventory Impact, 100% E15 (T50 Update) Relative to 100% E10 (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	2.9%	-2.7%	0.9%	-2.2%	-0.6%	-6.2%	0.0%	0.0%	0.0%	0.0%	0.8%
2011	Summer	CO	-5.4%	#N/A	-5.3%	#N/A	-6.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.2%
2011	Summer	NOX	3.9%	#N/A	3.5%	#N/A	3.7%	#N/A	0.0%	0.0%	#N/A	0.0%	2.4%
2011	Summer	PM2.5	0.9%	#N/A	1.1%	#N/A	2.9%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2011	Winter	THC	7.7%	-1.3%	7.2%	-1.2%	5.8%	-3.9%	0.0%	0.0%	0.0%	0.0%	5.6%
2011	Winter	CO	-8.3%	#N/A	-7.6%	#N/A	-7.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.0%
2011	Winter	NOX	3.9%	#N/A	3.5%	#N/A	3.4%	#N/A	0.0%	0.0%	#N/A	0.0%	2.3%
2011	Winter	PM2.5	1.0%	#N/A	0.8%	#N/A	1.7%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2022	Summer	THC	-3.5%	-1.4%	-3.3%	-1.7%	-2.1%	-6.3%	0.0%	0.0%	0.0%	0.0%	-2.4%
2022	Summer	CO	-5.8%	#N/A	-5.3%	#N/A	-6.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.6%
2022	Summer	NOX	2.2%	#N/A	2.3%	#N/A	3.4%	#N/A	0.0%	0.0%	#N/A	0.0%	1.3%
2022	Summer	PM2.5	2.1%	#N/A	2.6%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%
2022	Winter	THC	1.7%	-0.6%	2.4%	-1.0%	2.4%	-3.9%	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Winter	CO	-4.1%	#N/A	-3.7%	#N/A	-5.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.0%
2022	Winter	NOX	2.1%	#N/A	2.4%	#N/A	2.8%	#N/A	0.0%	0.0%	#N/A	0.0%	1.2%
2022	Winter	PM2.5	2.5%	#N/A	2.5%	#N/A	2.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.7%
2050	Summer	THC	-6.7%	-0.3%	-5.7%	-1.9%	-2.2%	-6.7%	0.0%	0.0%	0.0%	0.0%	-2.4%
2050	Summer	CO	-5.8%	#N/A	-4.5%	#N/A	-6.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.5%
2050	Summer	NOX	0.4%	#N/A	2.1%	#N/A	3.4%	#N/A	0.0%	0.0%	#N/A	0.0%	0.3%
2050	Summer	PM2.5	2.2%	#N/A	2.7%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.7%
2050	Winter	THC	-0.4%	0.0%	0.4%	-1.0%	2.3%	-4.2%	0.0%	0.0%	0.0%	0.0%	-0.3%
2050	Winter	CO	-2.7%	#N/A	-1.7%	#N/A	-5.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.5%
2050	Winter	NOX	0.2%	#N/A	2.0%	#N/A	2.8%	#N/A	0.0%	0.0%	#N/A	0.0%	0.2%
2050	Winter	PM2.5	3.1%	#N/A	3.0%	#N/A	2.6%	#N/A	0.0%	0.0%	0.0%	0.0%	2.4%

Table B-20
Fulton County (GA) Sensitivity Scenario 6 Emission Inventory, Remove LD I/M (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	14.769	6.693	0.875	0.236	0.112	0.131	0.191	1.192	0.040	0.177	24.415
2011	Summer	CO	270.628	0.000	20.442	0.000	1.540	0.000	3.585	6.177	0.067	0.291	302.728
2011	Summer	NOX	28.192	0.000	2.018	0.000	0.059	0.000	0.253	14.878	0.000	0.592	45.993
2011	Summer	PM2.5	0.254	0.000	0.013	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.134
2011	Winter	THC	16.788	3.321	0.769	0.121	0.053	0.058	0.194	1.146	0.038	0.167	22.655
2011	Winter	CO	210.509	0.000	17.120	0.000	0.749	0.000	2.277	5.192	0.058	0.274	236.178
2011	Winter	NOX	28.384	0.000	2.094	0.000	0.038	0.000	0.225	16.887	0.000	0.716	48.344
2011	Winter	PM2.5	0.537	0.000	0.028	0.000	0.002	0.000	0.003	0.608	0.152	0.009	1.338
2022	Summer	THC	4.502	3.858	0.265	0.124	0.087	0.153	0.050	0.379	0.006	0.146	9.569
2022	Summer	CO	158.568	0.000	11.290	0.000	1.258	0.000	1.714	2.327	0.010	0.272	175.436
2022	Summer	NOX	6.576	0.000	0.564	0.000	0.061	0.000	0.077	4.151	0.000	0.495	11.924
2022	Summer	PM2.5	0.207	0.000	0.010	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.380
2022	Winter	THC	5.891	2.158	0.248	0.073	0.039	0.067	0.089	0.472	0.006	0.137	9.181
2022	Winter	CO	109.650	0.000	8.841	0.000	0.580	0.000	0.994	2.014	0.009	0.256	122.344
2022	Winter	NOX	7.129	0.000	0.579	0.000	0.039	0.000	0.068	4.647	0.000	0.598	13.060
2022	Winter	PM2.5	0.257	0.000	0.012	0.000	0.001	0.000	0.002	0.105	0.033	0.003	0.412
2050	Summer	THC	1.344	2.804	0.131	0.108	0.114	0.206	0.017	0.290	0.000	0.160	5.175
2050	Summer	CO	67.469	0.000	6.164	0.000	1.638	0.000	0.834	2.078	0.000	0.306	78.489
2050	Summer	NOX	1.635	0.000	0.202	0.000	0.081	0.000	0.019	2.617	0.000	0.540	5.094
2050	Summer	PM2.5	0.146	0.000	0.013	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.219
2050	Winter	THC	3.560	1.848	0.144	0.075	0.052	0.093	0.084	0.454	0.000	0.151	6.460
2050	Winter	CO	55.825	0.000	5.776	0.000	0.758	0.000	0.487	1.874	0.000	0.288	65.008
2050	Winter	NOX	2.755	0.000	0.237	0.000	0.051	0.000	0.018	2.973	0.000	0.653	6.687
2050	Winter	PM2.5	0.147	0.000	0.012	0.000	0.001	0.000	0.001	0.034	0.008	0.003	0.207

Table B-21
Fulton County (GA) Sensitivity Scenario 6 Inventory Difference, Remove LD I/M Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	2.646	0.377	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000	3.027
2011	Summer	CO	38.600	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	38.600
2011	Summer	NOX	4.110	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.110
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC	2.132	0.146	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	2.279
2011	Winter	CO	23.478	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	23.478
2011	Winter	NOX	3.989	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.989
2011	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	THC	0.825	0.357	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	1.185
2022	Summer	CO	25.421	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.421
2022	Summer	NOX	0.876	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.876
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC	0.626	0.150	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.777
2022	Winter	CO	14.366	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	14.366
2022	Winter	NOX	0.823	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.823
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	THC	0.230	0.614	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.850
2050	Summer	CO	9.721	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9.721
2050	Summer	NOX	0.210	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.210
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC	0.169	0.260	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.430
2050	Winter	CO	5.419	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.419
2050	Winter	NOX	0.196	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.196
2050	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B-22
Fulton County (GA) Sensitivity Scenario 6, Percent Inventory Impact, Remove LD I/M Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	21.8%	6.0%	0.0%	1.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.2%
2011	Summer	CO	16.6%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	14.6%
2011	Summer	NOX	17.1%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	9.8%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC	14.5%	4.6%	0.0%	0.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	11.2%
2011	Winter	CO	12.6%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	11.0%
2011	Winter	NOX	16.4%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	9.0%
2011	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	THC	22.4%	10.2%	0.0%	2.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.1%
2022	Summer	CO	19.1%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	16.9%
2022	Summer	NOX	15.4%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	7.9%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC	11.9%	7.5%	0.0%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.2%
2022	Winter	CO	15.1%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	13.3%
2022	Winter	NOX	13.1%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	6.7%
2022	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	THC	20.6%	28.1%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	19.6%
2050	Summer	CO	16.8%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	14.1%
2050	Summer	NOX	14.7%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	4.3%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC	5.0%	16.4%	0.0%	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.1%
2050	Winter	CO	10.8%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	9.1%
2050	Winter	NOX	7.7%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	#N/A	0.0%	3.0%
2050	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%

Table B-23
Fulton County (GA) Scenario 7 Emission Inventory, Add SCR Start-Up (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	12.122	6.316	0.875	0.232	0.112	0.131	0.191	1.192	0.040	0.177	21.387
2011	Summer	CO	232.028	0.000	20.442	0.000	1.540	0.000	3.585	6.177	0.067	0.291	264.129
2011	Summer	NOX	24.082	0.000	2.018	0.000	0.059	0.000	0.253	14.955	0.000	0.592	41.960
2011	Summer	PM2.5	0.254	0.000	0.013	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.134
2011	Winter	THC	14.656	3.175	0.769	0.120	0.053	0.058	0.194	1.146	0.038	0.167	20.376
2011	Winter	CO	187.031	0.000	17.120	0.000	0.749	0.000	2.277	5.192	0.058	0.274	212.701
2011	Winter	NOX	24.395	0.000	2.094	0.000	0.038	0.000	0.225	16.964	0.000	0.716	44.432
2011	Winter	PM2.5	0.537	0.000	0.028	0.000	0.002	0.000	0.003	0.608	0.152	0.009	1.338
2022	Summer	THC	3.677	3.502	0.265	0.121	0.087	0.153	0.050	0.379	0.006	0.146	8.384
2022	Summer	CO	133.146	0.000	11.290	0.000	1.258	0.000	1.714	2.327	0.010	0.272	150.015
2022	Summer	NOX	5.700	0.000	0.564	0.000	0.061	0.000	0.077	4.681	0.000	0.495	11.577
2022	Summer	PM2.5	0.207	0.000	0.010	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.380
2022	Winter	THC	5.265	2.008	0.248	0.072	0.039	0.067	0.089	0.472	0.006	0.137	8.404
2022	Winter	CO	95.284	0.000	8.841	0.000	0.580	0.000	0.994	2.014	0.009	0.256	107.978
2022	Winter	NOX	6.306	0.000	0.579	0.000	0.039	0.000	0.068	5.176	0.000	0.598	12.766
2022	Winter	PM2.5	0.257	0.000	0.012	0.000	0.001	0.000	0.002	0.105	0.033	0.003	0.412
2050	Summer	THC	1.114	2.189	0.131	0.103	0.114	0.206	0.017	0.290	0.000	0.160	4.325
2050	Summer	CO	57.748	0.000	6.164	0.000	1.638	0.000	0.834	2.078	0.000	0.306	68.768
2050	Summer	NOX	1.425	0.000	0.202	0.000	0.081	0.000	0.019	3.612	0.000	0.540	5.879
2050	Summer	PM2.5	0.146	0.000	0.013	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.219
2050	Winter	THC	3.391	1.588	0.144	0.074	0.052	0.093	0.084	0.454	0.000	0.151	6.029
2050	Winter	CO	50.406	0.000	5.776	0.000	0.758	0.000	0.487	1.874	0.000	0.288	59.588
2050	Winter	NOX	2.559	0.000	0.237	0.000	0.051	0.000	0.018	3.968	0.000	0.653	7.486
2050	Winter	PM2.5	0.147	0.000	0.012	0.000	0.001	0.000	0.001	0.034	0.008	0.003	0.207

Table B-24
Fulton County (GA) Scenario 7 Inventory Difference, Add SCR Start-Up Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.077	0.000	0.000	0.077
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.077	0.000	0.000	0.077
2011	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.530	0.000	0.000	0.530
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.530	0.000	0.000	0.530
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.995	0.000	0.000	0.995
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.995	0.000	0.000	0.995
2050	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B-25
Fulton County (GA) Scenario 7, Percent Inventory Impact, Add SCR Start-Up Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.5%	#N/A	0.0%	0.2%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.5%	#N/A	0.0%	0.2%
2011	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	12.8%	#N/A	0.0%	4.8%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	11.4%	#N/A	0.0%	4.3%
2022	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	38.0%	#N/A	0.0%	20.4%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	33.5%	#N/A	0.0%	15.3%
2050	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%

Table B-26
Fulton County (GA) Sensitivity Scenario 8 Emission Inventory, Federal RFG (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	10.965	6.204	0.802	0.229	0.106	0.122	0.191	1.192	0.040	0.177	20.027
2011	Summer	CO	221.910	0.000	19.680	0.000	1.436	0.000	3.585	6.177	0.067	0.291	253.145
2011	Summer	NOX	23.668	0.000	1.988	0.000	0.059	0.000	0.253	14.878	0.000	0.592	41.438
2011	Summer	PM2.5	0.240	0.000	0.013	0.000	0.002	0.000	0.003	0.679	0.171	0.010	1.119
2011	Winter	THC	14.240	3.150	0.750	0.119	0.052	0.056	0.194	1.146	0.038	0.167	19.912
2011	Winter	CO	181.054	0.000	16.655	0.000	0.727	0.000	2.277	5.192	0.058	0.274	206.236
2011	Winter	NOX	24.508	0.000	2.107	0.000	0.038	0.000	0.225	16.887	0.000	0.716	44.482
2011	Winter	PM2.5	0.533	0.000	0.028	0.000	0.002	0.000	0.003	0.608	0.152	0.009	1.334
2022	Summer	THC	3.483	3.450	0.252	0.118	0.083	0.144	0.050	0.379	0.006	0.146	8.110
2022	Summer	CO	128.988	0.000	11.293	0.000	1.183	0.000	1.714	2.327	0.010	0.272	145.785
2022	Summer	NOX	5.632	0.000	0.559	0.000	0.061	0.000	0.077	4.151	0.000	0.495	10.975
2022	Summer	PM2.5	0.184	0.000	0.009	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.355
2022	Winter	THC	5.297	1.999	0.248	0.072	0.038	0.066	0.089	0.472	0.006	0.137	8.424
2022	Winter	CO	97.462	0.000	9.109	0.000	0.582	0.000	0.994	2.014	0.009	0.256	110.427
2022	Winter	NOX	6.411	0.000	0.588	0.000	0.039	0.000	0.068	4.647	0.000	0.598	12.351
2022	Winter	PM2.5	0.254	0.000	0.012	0.000	0.001	0.000	0.002	0.105	0.033	0.003	0.409
2050	Summer	THC	1.064	2.180	0.125	0.100	0.110	0.195	0.017	0.290	0.000	0.160	4.242
2050	Summer	CO	55.946	0.000	6.433	0.000	1.544	0.000	0.834	2.078	0.000	0.306	67.142
2050	Summer	NOX	1.407	0.000	0.201	0.000	0.080	0.000	0.019	2.617	0.000	0.540	4.864
2050	Summer	PM2.5	0.128	0.000	0.011	0.000	0.004	0.000	0.002	0.038	0.014	0.003	0.199
2050	Winter	THC	3.444	1.586	0.145	0.073	0.051	0.091	0.084	0.454	0.000	0.151	6.079
2050	Winter	CO	52.230	0.000	6.067	0.000	0.761	0.000	0.487	1.874	0.000	0.288	61.707
2050	Winter	NOX	2.625	0.000	0.241	0.000	0.052	0.000	0.018	2.973	0.000	0.653	6.562
2050	Winter	PM2.5	0.145	0.000	0.012	0.000	0.001	0.000	0.001	0.034	0.008	0.003	0.204

Table B-27
Fulton County (GA) Sensitivity Scenario 8 Inventory Difference, Federal RFG Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-1.157	-0.112	-0.073	-0.003	-0.007	-0.009	0.000	0.000	0.000	0.000	-1.360
2011	Summer	CO	-10.117	0.000	-0.762	0.000	-0.104	0.000	0.000	0.000	0.000	0.000	-10.984
2011	Summer	NOX	-0.414	0.000	-0.030	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.445
2011	Summer	PM2.5	-0.014	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.015
2011	Winter	THC	-0.416	-0.025	-0.019	-0.001	-0.001	-0.002	0.000	0.000	0.000	0.000	-0.464
2011	Winter	CO	-5.977	0.000	-0.465	0.000	-0.022	0.000	0.000	0.000	0.000	0.000	-6.465
2011	Winter	NOX	0.113	0.000	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.127
2011	Winter	PM2.5	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.004
2022	Summer	THC	-0.194	-0.052	-0.013	-0.002	-0.003	-0.009	0.000	0.000	0.000	0.000	-0.273
2022	Summer	CO	-4.158	0.000	0.003	0.000	-0.075	0.000	0.000	0.000	0.000	0.000	-4.230
2022	Summer	NOX	-0.068	0.000	-0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.073
2022	Summer	PM2.5	-0.023	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.024
2022	Winter	THC	0.032	-0.009	0.000	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.020
2022	Winter	CO	2.178	0.000	0.268	0.000	0.002	0.000	0.000	0.000	0.000	0.000	2.449
2022	Winter	NOX	0.105	0.000	0.009	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.115
2022	Winter	PM2.5	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.004
2050	Summer	THC	-0.050	-0.009	-0.006	-0.002	-0.005	-0.012	0.000	0.000	0.000	0.000	-0.083
2050	Summer	CO	-1.802	0.000	0.269	0.000	-0.094	0.000	0.000	0.000	0.000	0.000	-1.627
2050	Summer	NOX	-0.018	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.020
2050	Summer	PM2.5	-0.018	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.020
2050	Winter	THC	0.053	-0.002	0.001	-0.001	0.000	-0.002	0.000	0.000	0.000	0.000	0.050
2050	Winter	CO	1.824	0.000	0.291	0.000	0.003	0.000	0.000	0.000	0.000	0.000	2.118
2050	Winter	NOX	0.066	0.000	0.004	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.071
2050	Winter	PM2.5	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003

Table B-28
Fulton County (GA) Sensitivity Scenario 8, Percent Inventory Impact, Federal RFG Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-9.5%	-1.8%	-8.3%	-1.3%	-5.9%	-6.5%	0.0%	0.0%	0.0%	0.0%	-6.4%
2011	Summer	CO	-4.4%	#N/A	-3.7%	#N/A	-6.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.2%
2011	Summer	NOX	-1.7%	#N/A	-1.5%	#N/A	-1.0%	#N/A	0.0%	0.0%	#N/A	0.0%	-1.1%
2011	Summer	PM2.5	-5.4%	#N/A	-4.7%	#N/A	-7.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.3%
2011	Winter	THC	-2.8%	-0.8%	-2.5%	-0.7%	-1.6%	-3.8%	0.0%	0.0%	0.0%	0.0%	-2.3%
2011	Winter	CO	-3.2%	#N/A	-2.7%	#N/A	-2.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.0%
2011	Winter	NOX	0.5%	#N/A	0.7%	#N/A	0.8%	#N/A	0.0%	0.0%	#N/A	0.0%	0.3%
2011	Winter	PM2.5	-0.7%	#N/A	-0.6%	#N/A	-0.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.3%
2022	Summer	THC	-5.3%	-1.5%	-4.9%	-2.0%	-4.0%	-6.1%	0.0%	0.0%	0.0%	0.0%	-3.3%
2022	Summer	CO	-3.1%	#N/A	0.0%	#N/A	-6.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.8%
2022	Summer	NOX	-1.2%	#N/A	-0.9%	#N/A	-0.4%	#N/A	0.0%	0.0%	#N/A	0.0%	-0.7%
2022	Summer	PM2.5	-11.1%	#N/A	-10.6%	#N/A	-9.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-6.4%
2022	Winter	THC	0.6%	-0.5%	0.0%	-0.8%	-0.9%	-2.1%	0.0%	0.0%	0.0%	0.0%	0.2%
2022	Winter	CO	2.3%	#N/A	3.0%	#N/A	0.3%	#N/A	0.0%	0.0%	0.0%	0.0%	2.3%
2022	Winter	NOX	1.7%	#N/A	1.5%	#N/A	1.3%	#N/A	0.0%	0.0%	#N/A	0.0%	0.9%
2022	Winter	PM2.5	-1.3%	#N/A	-1.1%	#N/A	-0.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.9%
2050	Summer	THC	-4.5%	-0.4%	-4.5%	-2.2%	-4.1%	-5.6%	0.0%	0.0%	0.0%	0.0%	-1.9%
2050	Summer	CO	-3.1%	#N/A	4.4%	#N/A	-5.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.4%
2050	Summer	NOX	-1.2%	#N/A	-0.7%	#N/A	-0.4%	#N/A	0.0%	0.0%	#N/A	0.0%	-0.4%
2050	Summer	PM2.5	-12.2%	#N/A	-11.5%	#N/A	-9.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-9.0%
2050	Winter	THC	1.6%	-0.1%	0.9%	-0.8%	-0.8%	-2.2%	0.0%	0.0%	0.0%	0.0%	0.8%
2050	Winter	CO	3.6%	#N/A	5.0%	#N/A	0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	3.6%
2050	Winter	NOX	2.6%	#N/A	1.7%	#N/A	1.3%	#N/A	0.0%	0.0%	#N/A	0.0%	1.1%
2050	Winter	PM2.5	-1.7%	#N/A	-1.4%	#N/A	-0.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.3%

Table B-29

Fulton County (GA) Sensitivity Scenario 9 Emission Inventory, National LDA/LDT Mix (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	**Season**	**Pollutant**	**Exhaust**	**Evap.**	**Exhaust**	**Evap.**	**Exhaust**	**Evap.**	**Exhaust**	**Exhaust**	**Crank Case**	**Idling / APU**	**Total On-Road**
2011	Summer	THC	11.642	6.203	0.875	0.232	0.112	0.131	0.180	1.192	0.040	0.177	20.784
2011	Summer	CO	224.285	0.000	20.442	0.000	1.540	0.000	3.387	6.177	0.067	0.291	256.189
2011	Summer	NOX	23.092	0.000	2.018	0.000	0.059	0.000	0.244	14.878	0.000	0.592	40.884
2011	Summer	PM2.5	0.249	0.000	0.013	0.000	0.003	0.000	0.003	0.679	0.171	0.010	1.129
2011	Winter	THC	14.274	3.125	0.769	0.120	0.053	0.058	0.184	1.146	0.038	0.167	19.933
2011	Winter	CO	182.109	0.000	17.120	0.000	0.749	0.000	2.144	5.192	0.058	0.274	207.645
2011	Winter	NOX	23.432	0.000	2.094	0.000	0.038	0.000	0.216	16.887	0.000	0.716	43.384
2011	Winter	PM2.5	0.528	0.000	0.028	0.000	0.002	0.000	0.003	0.608	0.152	0.009	1.329
2022	Summer	THC	3.634	3.505	0.265	0.121	0.087	0.153	0.048	0.379	0.006	0.146	8.343
2022	Summer	CO	130.753	0.000	11.290	0.000	1.258	0.000	1.643	2.327	0.010	0.272	147.551
2022	Summer	NOX	5.581	0.000	0.564	0.000	0.061	0.000	0.075	4.151	0.000	0.495	10.927
2022	Summer	PM2.5	0.204	0.000	0.010	0.000	0.003	0.000	0.002	0.117	0.036	0.004	0.376
2022	Winter	THC	5.220	2.004	0.248	0.072	0.039	0.067	0.085	0.472	0.006	0.137	8.351
2022	Winter	CO	93.980	0.000	8.841	0.000	0.580	0.000	0.953	2.014	0.009	0.256	106.633
2022	Winter	NOX	6.195	0.000	0.579	0.000	0.039	0.000	0.066	4.647	0.000	0.598	12.124
2022	Winter	PM2.5	0.253	0.000	0.012	0.000	0.001	0.000	0.002	0.105	0.033	0.003	0.408
2050	Summer	THC	1.109	2.172	0.131	0.103	0.114	0.206	0.016	0.290	0.000	0.160	4.302
2050	Summer	CO	57.213	0.000	6.164	0.000	1.638	0.000	0.795	2.078	0.000	0.306	68.193
2050	Summer	NOX	1.413	0.000	0.202	0.000	0.081	0.000	0.018	2.617	0.000	0.540	4.871
2050	Summer	PM2.5	0.143	0.000	0.013	0.000	0.004	0.000	0.001	0.038	0.014	0.003	0.216
2050	Winter	THC	3.377	1.575	0.144	0.074	0.052	0.093	0.080	0.454	0.000	0.151	5.999
2050	Winter	CO	50.089	0.000	5.776	0.000	0.758	0.000	0.464	1.874	0.000	0.288	59.249
2050	Winter	NOX	2.542	0.000	0.237	0.000	0.051	0.000	0.017	2.973	0.000	0.653	6.474
2050	Winter	PM2.5	0.144	0.000	0.012	0.000	0.001	0.000	0.001	0.034	0.008	0.003	0.204

Table B-30

Fulton County (GA) Sensitivity Scenario 9 Inventory Difference, National LDA/LDT Mix Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	**Season**	**Pollutant**	**Exhaust**	**Evap.**	**Exhaust**	**Evap.**	**Exhaust**	**Evap.**	**Exhaust**	**Exhaust**	**Crank Case**	**Idling / APU**	**Total On-Road**
2011	Summer	THC	-0.480	-0.113	0.000	0.000	0.000	0.000	-0.011	0.000	0.000	0.000	-0.603
2011	Summer	CO	-7.743	0.000	0.000	0.000	0.000	0.000	-0.197	0.000	0.000	0.000	-7.940
2011	Summer	NOX	-0.990	0.000	0.000	0.000	0.000	0.000	-0.009	0.000	0.000	0.000	-0.999
2011	Summer	PM2.5	-0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.005
2011	Winter	THC	-0.382	-0.050	0.000	0.000	0.000	0.000	-0.011	0.000	0.000	0.000	-0.442
2011	Winter	CO	-4.922	0.000	0.000	0.000	0.000	0.000	-0.134	0.000	0.000	0.000	-5.055
2011	Winter	NOX	-0.962	0.000	0.000	0.000	0.000	0.000	-0.008	0.000	0.000	0.000	-0.971
2011	Winter	PM2.5	-0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.009
2022	Summer	THC	-0.042	0.003	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	-0.041
2022	Summer	CO	-2.393	0.000	0.000	0.000	0.000	0.000	-0.071	0.000	0.000	0.000	-2.464
2022	Summer	NOX	-0.119	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	-0.121
2022	Summer	PM2.5	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.004
2022	Winter	THC	-0.046	-0.003	0.000	0.000	0.000	0.000	-0.004	0.000	0.000	0.000	-0.053
2022	Winter	CO	-1.304	0.000	0.000	0.000	0.000	0.000	-0.042	0.000	0.000	0.000	-1.345
2022	Winter	NOX	-0.111	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	-0.113
2022	Winter	PM2.5	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.004
2050	Summer	THC	-0.005	-0.018	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	-0.023
2050	Summer	CO	-0.536	0.000	0.000	0.000	0.000	0.000	-0.039	0.000	0.000	0.000	-0.575
2050	Summer	NOX	-0.012	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	-0.013
2050	Summer	PM2.5	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003
2050	Winter	THC	-0.013	-0.013	0.000	0.000	0.000	0.000	-0.004	0.000	0.000	0.000	-0.030
2050	Winter	CO	-0.316	0.000	0.000	0.000	0.000	0.000	-0.023	0.000	0.000	0.000	-0.340
2050	Winter	NOX	-0.016	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	-0.017
2050	Winter	PM2.5	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003

Table B-31
Fulton County (GA) Sensitivity Scenario 9, Percent Inventory Impact, National LDA/LDT Mix Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-4.0%	-1.8%	0.0%	0.0%	0.0%	0.0%	-5.6%	0.0%	0.0%	0.0%	-2.8%
2011	Summer	CO	-3.3%	#N/A	0.0%	#N/A	0.0%	#N/A	-5.5%	0.0%	0.0%	0.0%	-3.0%
2011	Summer	NOX	-4.1%	#N/A	0.0%	#N/A	0.0%	#N/A	-3.6%	0.0%	#N/A	0.0%	-2.4%
2011	Summer	PM2.5	-1.9%	#N/A	0.0%	#N/A	0.0%	#N/A	-6.9%	0.0%	0.0%	0.0%	-0.4%
2011	Winter	THC	-2.6%	-1.6%	0.0%	0.0%	0.0%	0.0%	-5.5%	0.0%	0.0%	0.0%	-2.2%
2011	Winter	CO	-2.6%	#N/A	0.0%	#N/A	0.0%	#N/A	-5.9%	0.0%	0.0%	0.0%	-2.4%
2011	Winter	NOX	-3.9%	#N/A	0.0%	#N/A	0.0%	#N/A	-3.7%	0.0%	#N/A	0.0%	-2.2%
2011	Winter	PM2.5	-1.6%	#N/A	0.0%	#N/A	0.0%	#N/A	-7.0%	0.0%	0.0%	0.0%	-0.7%
2022	Summer	THC	-1.2%	0.1%	0.0%	0.0%	0.0%	0.0%	-3.9%	0.0%	0.0%	0.0%	-0.5%
2022	Summer	CO	-1.8%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.1%	0.0%	0.0%	0.0%	-1.6%
2022	Summer	NOX	-2.1%	#N/A	0.0%	#N/A	0.0%	#N/A	-3.0%	0.0%	#N/A	0.0%	-1.1%
2022	Summer	PM2.5	-1.9%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.0%	0.0%	0.0%	0.0%	-1.1%
2022	Winter	THC	-0.9%	-0.2%	0.0%	0.0%	0.0%	0.0%	-4.6%	0.0%	0.0%	0.0%	-0.6%
2022	Winter	CO	-1.4%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.2%	0.0%	0.0%	0.0%	-1.2%
2022	Winter	NOX	-1.8%	#N/A	0.0%	#N/A	0.0%	#N/A	-3.0%	0.0%	#N/A	0.0%	-0.9%
2022	Winter	PM2.5	-1.5%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.1%	0.0%	0.0%	0.0%	-0.9%
2050	Summer	THC	-0.4%	-0.8%	0.0%	0.0%	0.0%	0.0%	-4.9%	0.0%	0.0%	0.0%	-0.5%
2050	Summer	CO	-0.9%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.7%	0.0%	0.0%	0.0%	-0.8%
2050	Summer	NOX	-0.9%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.7%	0.0%	#N/A	0.0%	-0.3%
2050	Summer	PM2.5	-1.9%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.1%	0.0%	0.0%	0.0%	-1.3%
2050	Winter	THC	-0.4%	-0.8%	0.0%	0.0%	0.0%	0.0%	-4.9%	0.0%	0.0%	0.0%	-0.5%
2050	Winter	CO	-0.6%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.7%	0.0%	0.0%	0.0%	-0.6%
2050	Winter	NOX	-0.6%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.7%	0.0%	#N/A	0.0%	-0.3%
2050	Winter	PM2.5	-1.8%	#N/A	0.0%	#N/A	0.0%	#N/A	-4.1%	0.0%	0.0%	0.0%	-1.3%

Table B-32
Maricopa County (AZ) Sensitivity Scenario 1 Emission Inventory, +1 PSI RVP (Fuel Wizard) (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	23.206	29.969	1.357	0.678	1.725	2.087	0.506	4.009	0.159	0.657	64.354
2011	Summer	CO	519.370	0.000	39.067	0.000	23.842	0.000	9.280	19.679	0.324	1.031	612.592
2011	Summer	NOX	51.860	0.000	3.673	0.000	1.168	0.000	0.579	61.402	0.048	2.680	121.411
2011	Summer	PM2.5	0.590	0.000	0.036	0.000	0.038	0.000	0.009	2.588	0.619	0.039	3.918
2011	Winter	THC	28.213	14.080	1.367	0.360	1.681	1.347	0.545	4.323	0.170	0.694	52.778
2011	Winter	CO	453.060	0.000	37.628	0.000	25.548	0.000	7.193	20.082	0.313	1.114	544.939
2011	Winter	NOX	53.609	0.000	4.082	0.000	1.449	0.000	0.560	71.848	0.056	3.155	134.758
2011	Winter	PM2.5	1.006	0.000	0.057	0.000	0.044	0.000	0.009	2.734	0.654	0.041	4.544
2022	Summer	THC	11.045	18.340	0.526	0.531	1.449	2.358	0.174	1.198	0.011	0.760	36.392
2022	Summer	CO	383.341	0.000	23.842	0.000	21.478	0.000	5.157	6.503	0.026	1.421	441.768
2022	Summer	NOX	18.438	0.000	1.406	0.000	1.342	0.000	0.249	17.566	0.003	2.961	41.966
2022	Summer	PM2.5	0.449	0.000	0.034	0.000	0.046	0.000	0.006	0.312	0.136	0.014	0.996
2022	Winter	THC	13.096	9.823	0.512	0.309	1.380	1.624	0.258	1.426	0.012	0.802	29.241
2022	Winter	CO	309.660	0.000	21.830	0.000	22.881	0.000	3.556	6.608	0.023	1.503	366.060
2022	Winter	NOX	20.164	0.000	1.573	0.000	1.660	0.000	0.237	20.488	0.003	3.486	47.612
2022	Winter	PM2.5	0.569	0.000	0.037	0.000	0.047	0.000	0.006	0.329	0.144	0.015	1.147
2050	Summer	THC	4.266	13.114	0.418	0.671	2.267	3.655	0.071	1.690	0.001	1.416	27.568
2050	Summer	CO	215.002	0.000	20.233	0.000	33.871	0.000	3.204	9.539	0.002	2.692	284.543
2050	Summer	NOX	6.019	0.000	1.005	0.000	2.169	0.000	0.081	21.571	0.000	5.493	36.339
2050	Summer	PM2.5	0.356	0.000	0.053	0.000	0.075	0.000	0.006	0.304	0.185	0.024	1.004
2050	Winter	THC	8.161	8.676	0.419	0.425	2.150	2.583	0.231	2.075	0.001	1.494	26.215
2050	Winter	CO	190.604	0.000	20.327	0.000	36.020	0.000	2.182	9.783	0.001	2.842	261.759
2050	Winter	NOX	8.915	0.000	1.199	0.000	2.681	0.000	0.078	25.281	0.000	6.466	44.620
2050	Winter	PM2.5	0.389	0.000	0.054	0.000	0.075	0.000	0.006	0.321	0.196	0.026	1.066

Table B-33
Maricopa County (AZ) Sensitivity Scenario 1 Inventory Difference, +1 PSI RVP (Fuel Wizard) Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-0.339	1.726	-0.028	0.041	-0.057	0.157	0.000	0.000	0.000	0.000	1.499
2011	Summer	CO	0.088	0.000	0.065	0.000	0.197	0.000	0.000	0.000	0.000	0.000	0.349
2011	Summer	NOX	0.403	0.000	0.018	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.423
2011	Summer	PM2.5	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.005
2011	Winter	THC	-0.259	0.507	-0.018	0.022	-0.048	0.079	0.000	0.000	0.000	0.000	0.282
2011	Winter	CO	9.703	0.000	0.753	0.000	0.351	0.000	0.000	0.000	0.000	0.000	10.808
2011	Winter	NOX	0.418	0.000	0.022	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.442
2011	Winter	PM2.5	-0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.006
2022	Summer	THC	-0.438	0.772	-0.019	0.036	-0.056	0.172	0.000	0.000	0.000	0.000	0.468
2022	Summer	CO	2.947	0.000	0.178	0.000	0.226	0.000	0.000	0.000	0.000	0.000	3.352
2022	Summer	NOX	0.056	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.058
2022	Summer	PM2.5	-0.007	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.008
2022	Winter	THC	-0.436	0.225	-0.015	0.020	-0.048	0.097	0.000	0.000	0.000	0.000	-0.156
2022	Winter	CO	4.258	0.000	0.304	0.000	0.261	0.000	0.000	0.000	0.000	0.000	4.822
2022	Winter	NOX	0.053	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.055
2022	Winter	PM2.5	-0.008	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.009
2050	Summer	THC	-0.216	0.645	-0.019	0.057	-0.089	0.281	0.000	0.000	0.000	0.000	0.659
2050	Summer	CO	2.158	0.000	0.189	0.000	0.371	0.000	0.000	0.000	0.000	0.000	2.718
2050	Summer	NOX	-0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.013
2050	Summer	PM2.5	-0.007	0.000	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.009
2050	Winter	THC	-0.363	0.130	-0.017	0.031	-0.076	0.158	0.000	0.000	0.000	0.000	-0.137
2050	Winter	CO	2.293	0.000	0.254	0.000	0.399	0.000	0.000	0.000	0.000	0.000	2.946
2050	Winter	NOX	-0.025	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.026
2050	Winter	PM2.5	-0.008	0.000	-0.001	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.009

Table B-34
Maricopa County (AZ) Sensitivity Scenario 1, Percent Inventory Impact, +1 PSI RVP (Fuel Wizard) Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-1.4%	6.1%	-2.1%	6.4%	-3.2%	8.2%	0.0%	0.0%	0.0%	0.0%	2.4%
2011	Summer	CO	0.0%	#N/A	0.2%	#N/A	0.8%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2011	Summer	NOX	0.8%	#N/A	0.5%	#N/A	0.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Summer	PM2.5	-0.7%	#N/A	-0.6%	#N/A	-1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2011	Winter	THC	-0.9%	3.7%	-1.3%	6.4%	-2.8%	6.2%	0.0%	0.0%	0.0%	0.0%	0.5%
2011	Winter	CO	2.2%	#N/A	2.0%	#N/A	1.4%	#N/A	0.0%	0.0%	0.0%	0.0%	2.0%
2011	Winter	NOX	0.8%	#N/A	0.5%	#N/A	0.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Winter	PM2.5	-0.5%	#N/A	-0.5%	#N/A	-1.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2022	Summer	THC	-3.8%	4.4%	-3.5%	7.4%	-3.7%	7.9%	0.0%	0.0%	0.0%	0.0%	1.3%
2022	Summer	CO	0.8%	#N/A	0.8%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.8%
2022	Summer	NOX	0.3%	#N/A	0.1%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2022	Summer	PM2.5	-1.6%	#N/A	-1.3%	#N/A	-1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.8%
2022	Winter	THC	-3.2%	2.3%	-2.9%	6.9%	-3.3%	6.4%	0.0%	0.0%	0.0%	0.0%	-0.5%
2022	Winter	CO	1.4%	#N/A	1.4%	#N/A	1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	1.3%
2022	Winter	NOX	0.3%	#N/A	0.1%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2022	Winter	PM2.5	-1.4%	#N/A	-1.2%	#N/A	-1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.8%
2050	Summer	THC	-4.8%	5.2%	-4.4%	9.3%	-3.8%	8.3%	0.0%	0.0%	0.0%	0.0%	2.4%
2050	Summer	CO	1.0%	#N/A	0.9%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2050	Summer	NOX	-0.2%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	PM2.5	-1.9%	#N/A	-1.4%	#N/A	-1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.8%
2050	Winter	THC	-4.3%	1.5%	-3.9%	7.9%	-3.4%	6.5%	0.0%	0.0%	0.0%	0.0%	-0.5%
2050	Winter	CO	1.2%	#N/A	1.3%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2050	Winter	NOX	-0.3%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2050	Winter	PM2.5	-2.0%	#N/A	-1.4%	#N/A	-1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.9%

Table B-35
Maricopa County (AZ) Sensitivity Scenario 2 Emission Inventory, +1 PSI RVP (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	23.566	29.969	1.378	0.678	1.752	2.087	0.506	4.009	0.159	0.657	64.762
2011	Summer	CO	520.020	0.000	39.073	0.000	23.995	0.000	9.280	19.679	0.324	1.031	613.402
2011	Summer	NOX	51.890	0.000	3.675	0.000	1.168	0.000	0.579	61.402	0.048	2.680	121.443
2011	Summer	PM2.5	0.594	0.000	0.036	0.000	0.038	0.000	0.009	2.588	0.619	0.039	3.923
2011	Winter	THC	28.464	14.080	1.379	0.360	1.700	1.347	0.545	4.323	0.170	0.694	53.061
2011	Winter	CO	451.523	0.000	37.507	0.000	25.696	0.000	7.193	20.082	0.313	1.114	543.428
2011	Winter	NOX	53.636	0.000	4.083	0.000	1.449	0.000	0.560	71.848	0.056	3.155	134.786
2011	Winter	PM2.5	1.011	0.000	0.057	0.000	0.045	0.000	0.009	2.734	0.654	0.041	4.550
2022	Summer	THC	11.279	18.340	0.536	0.531	1.473	2.358	0.174	1.198	0.011	0.760	36.659
2022	Summer	CO	384.086	0.000	23.833	0.000	21.630	0.000	5.157	6.503	0.026	1.421	442.656
2022	Summer	NOX	18.461	0.000	1.407	0.000	1.342	0.000	0.249	17.566	0.003	2.961	41.990
2022	Summer	PM2.5	0.456	0.000	0.034	0.000	0.047	0.000	0.006	0.312	0.136	0.014	1.004
2022	Winter	THC	13.283	9.823	0.519	0.309	1.397	1.624	0.258	1.426	0.012	0.802	29.453
2022	Winter	CO	308.429	0.000	21.732	0.000	23.035	0.000	3.556	6.608	0.023	1.503	364.886
2022	Winter	NOX	20.193	0.000	1.574	0.000	1.660	0.000	0.237	20.488	0.003	3.486	47.642
2022	Winter	PM2.5	0.578	0.000	0.038	0.000	0.047	0.000	0.006	0.329	0.144	0.015	1.156
2050	Summer	THC	4.366	13.114	0.426	0.671	2.304	3.655	0.071	1.690	0.001	1.416	27.714
2050	Summer	CO	215.510	0.000	20.165	0.000	34.113	0.000	3.204	9.539	0.002	2.692	285.226
2050	Summer	NOX	6.032	0.000	1.006	0.000	2.169	0.000	0.081	21.571	0.000	5.493	36.352
2050	Summer	PM2.5	0.363	0.000	0.054	0.000	0.076	0.000	0.006	0.304	0.185	0.024	1.013
2050	Winter	THC	8.299	8.676	0.425	0.425	2.177	2.583	0.231	2.075	0.001	1.494	26.387
2050	Winter	CO	189.582	0.000	20.170	0.000	36.269	0.000	2.182	9.783	0.001	2.842	260.830
2050	Winter	NOX	8.941	0.000	1.200	0.000	2.681	0.000	0.078	25.281	0.000	6.466	44.646
2050	Winter	PM2.5	0.397	0.000	0.055	0.000	0.076	0.000	0.006	0.321	0.196	0.026	1.076

Table B-36
Maricopa County (AZ) Sensitivity Scenario 2 Inventory Difference, +1 PSI RVP Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.021	1.726	-0.007	0.041	-0.030	0.157	0.000	0.000	0.000	0.000	1.908
2011	Summer	CO	0.738	0.000	0.071	0.000	0.350	0.000	0.000	0.000	0.000	0.000	1.159
2011	Summer	NOX	0.434	0.000	0.020	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.455
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC	-0.009	0.507	-0.005	0.022	-0.028	0.079	0.000	0.000	0.000	0.000	0.564
2011	Winter	CO	8.166	0.000	0.632	0.000	0.499	0.000	0.000	0.000	0.000	0.000	9.297
2011	Winter	NOX	0.444	0.000	0.023	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.469
2011	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	THC	-0.204	0.772	-0.009	0.036	-0.032	0.172	0.000	0.000	0.000	0.000	0.736
2022	Summer	CO	3.692	0.000	0.170	0.000	0.378	0.000	0.000	0.000	0.000	0.000	4.240
2022	Summer	NOX	0.079	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.082
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC	-0.248	0.225	-0.009	0.020	-0.030	0.097	0.000	0.000	0.000	0.000	0.055
2022	Winter	CO	3.027	0.000	0.205	0.000	0.416	0.000	0.000	0.000	0.000	0.000	3.648
2022	Winter	NOX	0.082	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.085
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	THC	-0.116	0.645	-0.011	0.057	-0.052	0.281	0.000	0.000	0.000	0.000	0.804
2050	Summer	CO	2.666	0.000	0.122	0.000	0.613	0.000	0.000	0.000	0.000	0.000	3.401
2050	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC	-0.225	0.130	-0.011	0.031	-0.049	0.158	0.000	0.000	0.000	0.000	0.035
2050	Winter	CO	1.271	0.000	0.097	0.000	0.648	0.000	0.000	0.000	0.000	0.000	2.017
2050	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B-37
Maricopa County (AZ) Sensitivity Scenario 2, Percent Inventory Impact, +1 PSI RVP Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.1%	6.1%	-0.5%	6.4%	-1.7%	8.2%	0.0%	0.0%	0.0%	0.0%	3.0%
2011	Summer	CO	0.1%	#N/A	0.2%	#N/A	1.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2011	Summer	NOX	0.8%	#N/A	0.6%	#N/A	0.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC	0.0%	3.7%	-0.4%	6.4%	-1.6%	6.2%	0.0%	0.0%	0.0%	0.0%	1.1%
2011	Winter	CO	1.8%	#N/A	1.7%	#N/A	2.0%	#N/A	0.0%	0.0%	0.0%	0.0%	1.7%
2011	Winter	NOX	0.8%	#N/A	0.6%	#N/A	0.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	THC	-1.8%	4.4%	-1.7%	7.4%	-2.1%	7.9%	0.0%	0.0%	0.0%	0.0%	2.0%
2022	Summer	CO	1.0%	#N/A	0.7%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Summer	NOX	0.4%	#N/A	0.2%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC	-1.8%	2.3%	-1.7%	6.9%	-2.1%	6.4%	0.0%	0.0%	0.0%	0.0%	0.2%
2022	Winter	CO	1.0%	#N/A	1.0%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Winter	NOX	0.4%	#N/A	0.2%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2022	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	THC	-2.6%	5.2%	-2.4%	9.3%	-2.2%	8.3%	0.0%	0.0%	0.0%	0.0%	3.0%
2050	Summer	CO	1.3%	#N/A	0.6%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%
2050	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC	-2.6%	1.5%	-2.4%	7.9%	-2.2%	6.5%	0.0%	0.0%	0.0%	0.0%	0.1%
2050	Winter	CO	0.7%	#N/A	0.5%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	0.8%
2050	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%

Table B-38
Maricopa County (AZ) Sensitivity Scenario 4 Emission Inventory, 100% E15 (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	23.431	28.310	1.370	0.643	1.751	1.935	0.506	4.009	0.159	0.657	62.772
2011	Summer	CO	492.606	0.000	37.151	0.000	22.715	0.000	9.280	19.679	0.324	1.031	582.787
2011	Summer	NOX	53.643	0.000	3.794	0.000	1.206	0.000	0.579	61.402	0.048	2.680	123.353
2011	Summer	PM2.5	0.596	0.000	0.037	0.000	0.039	0.000	0.009	2.588	0.619	0.039	3.926
2011	Winter	THC	28.741	13.608	1.396	0.341	1.726	1.271	0.545	4.323	0.170	0.694	52.814
2011	Winter	CO	424.471	0.000	35.408	0.000	24.370	0.000	7.193	20.082	0.313	1.114	512.951
2011	Winter	NOX	55.664	0.000	4.234	0.000	1.501	0.000	0.560	71.848	0.056	3.155	137.016
2011	Winter	PM2.5	1.018	0.000	0.058	0.000	0.046	0.000	0.009	2.734	0.654	0.041	4.559
2022	Summer	THC	10.976	17.592	0.528	0.500	1.469	2.192	0.174	1.198	0.011	0.760	35.400
2022	Summer	CO	367.111	0.000	22.856	0.000	20.511	0.000	5.157	6.503	0.026	1.421	423.585
2022	Summer	NOX	18.942	0.000	1.448	0.000	1.385	0.000	0.249	17.566	0.003	2.961	42.553
2022	Summer	PM2.5	0.458	0.000	0.035	0.000	0.048	0.000	0.006	0.312	0.136	0.014	1.008
2022	Winter	THC	13.148	9.611	0.520	0.293	1.417	1.530	0.258	1.426	0.012	0.802	29.016
2022	Winter	CO	297.067	0.000	20.938	0.000	21.966	0.000	3.556	6.608	0.023	1.503	351.660
2022	Winter	NOX	20.788	0.000	1.626	0.000	1.717	0.000	0.237	20.488	0.003	3.486	48.346
2022	Winter	PM2.5	0.587	0.000	0.039	0.000	0.049	0.000	0.006	0.329	0.144	0.015	1.168
2050	Summer	THC	4.212	12.486	0.418	0.623	2.298	3.384	0.071	1.690	0.001	1.416	26.599
2050	Summer	CO	206.246	0.000	19.473	0.000	32.354	0.000	3.204	9.539	0.002	2.692	273.510
2050	Summer	NOX	6.133	0.000	1.034	0.000	2.237	0.000	0.081	21.571	0.000	5.493	36.550
2050	Summer	PM2.5	0.365	0.000	0.055	0.000	0.078	0.000	0.006	0.304	0.185	0.024	1.018
2050	Winter	THC	8.132	8.555	0.423	0.400	2.206	2.430	0.231	2.075	0.001	1.494	25.948
2050	Winter	CO	183.977	0.000	19.620	0.000	34.611	0.000	2.182	9.783	0.001	2.842	253.017
2050	Winter	NOX	9.108	0.000	1.238	0.000	2.773	0.000	0.078	25.281	0.000	6.466	44.944
2050	Winter	PM2.5	0.405	0.000	0.057	0.000	0.078	0.000	0.006	0.321	0.196	0.026	1.089

Table B-39
Maricopa County (AZ) Sensitivity Scenario 4 Inventory Difference, 100% E15 Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-0.114	0.067	-0.015	0.006	-0.031	0.005	0.000	0.000	0.000	0.000	-0.082
2011	Summer	CO	-26.675	0.000	-1.851	0.000	-0.930	0.000	0.000	0.000	0.000	0.000	-29.456
2011	Summer	NOX	2.187	0.000	0.139	0.000	0.039	0.000	0.000	0.000	0.000	0.000	2.365
2011	Summer	PM2.5	0.002	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.003
2011	Winter	THC	0.268	0.035	0.011	0.003	-0.002	0.003	0.000	0.000	0.000	0.000	0.318
2011	Winter	CO	-18.886	0.000	-1.467	0.000	-0.827	0.000	0.000	0.000	0.000	0.000	-21.180
2011	Winter	NOX	2.472	0.000	0.173	0.000	0.054	0.000	0.000	0.000	0.000	0.000	2.699
2011	Winter	PM2.5	0.007	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.009
2022	Summer	THC	-0.506	0.023	-0.017	0.006	-0.035	0.006	0.000	0.000	0.000	0.000	-0.523
2022	Summer	CO	-13.283	0.000	-0.807	0.000	-0.741	0.000	0.000	0.000	0.000	0.000	-14.832
2022	Summer	NOX	0.560	0.000	0.043	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.645
2022	Summer	PM2.5	0.002	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.004
2022	Winter	THC	-0.383	0.013	-0.007	0.003	-0.011	0.003	0.000	0.000	0.000	0.000	-0.382
2022	Winter	CO	-8.335	0.000	-0.589	0.000	-0.654	0.000	0.000	0.000	0.000	0.000	-9.578
2022	Winter	NOX	0.677	0.000	0.054	0.000	0.058	0.000	0.000	0.000	0.000	0.000	0.789
2022	Winter	PM2.5	0.009	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.012
2050	Summer	THC	-0.269	0.017	-0.019	0.009	-0.058	0.010	0.000	0.000	0.000	0.000	-0.311
2050	Summer	CO	-6.598	0.000	-0.570	0.000	-1.146	0.000	0.000	0.000	0.000	0.000	-8.314
2050	Summer	NOX	0.101	0.000	0.029	0.000	0.068	0.000	0.000	0.000	0.000	0.000	0.197
2050	Summer	PM2.5	0.002	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.005
2050	Winter	THC	-0.392	0.010	-0.012	0.005	-0.020	0.005	0.000	0.000	0.000	0.000	-0.404
2050	Winter	CO	-4.334	0.000	-0.453	0.000	-1.010	0.000	0.000	0.000	0.000	0.000	-5.796
2050	Winter	NOX	0.167	0.000	0.038	0.000	0.092	0.000	0.000	0.000	0.000	0.000	0.298
2050	Winter	PM2.5	0.009	0.000	0.002	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.013

Table B-40
Maricopa County (AZ) Sensitivity Scenario 4, Percent Inventory Impact, 100% E15 Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-0.5%	0.2%	-1.1%	0.9%	-1.7%	0.3%	0.0%	0.0%	0.0%	0.0%	-0.1%
2011	Summer	CO	-5.1%	#N/A	-4.7%	#N/A	-3.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.8%
2011	Summer	NOX	4.2%	#N/A	3.8%	#N/A	3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	2.0%
2011	Summer	PM2.5	0.3%	#N/A	1.0%	#N/A	2.2%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2011	Winter	THC	0.9%	0.3%	0.8%	0.9%	-0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.6%
2011	Winter	CO	-4.3%	#N/A	-4.0%	#N/A	-3.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.0%
2011	Winter	NOX	4.6%	#N/A	4.3%	#N/A	3.7%	#N/A	0.0%	0.0%	0.0%	0.0%	2.0%
2011	Winter	PM2.5	0.7%	#N/A	1.2%	#N/A	2.9%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2022	Summer	THC	-4.4%	0.1%	-3.1%	1.2%	-2.4%	0.3%	0.0%	0.0%	0.0%	0.0%	-1.5%
2022	Summer	CO	-3.5%	#N/A	-3.4%	#N/A	-3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.4%
2022	Summer	NOX	3.0%	#N/A	3.0%	#N/A	3.2%	#N/A	0.0%	0.0%	0.0%	0.0%	1.5%
2022	Summer	PM2.5	0.5%	#N/A	1.9%	#N/A	2.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2022	Winter	THC	-2.8%	0.1%	-1.4%	1.2%	-0.8%	0.2%	0.0%	0.0%	0.0%	0.0%	-1.3%
2022	Winter	CO	-2.7%	#N/A	-2.7%	#N/A	-2.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.7%
2022	Winter	NOX	3.4%	#N/A	3.5%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.7%
2022	Winter	PM2.5	1.6%	#N/A	2.8%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2050	Summer	THC	-6.0%	0.1%	-4.4%	1.5%	-2.5%	0.3%	0.0%	0.0%	0.0%	0.0%	-1.2%
2050	Summer	CO	-3.1%	#N/A	-2.8%	#N/A	-3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.0%
2050	Summer	NOX	1.7%	#N/A	2.8%	#N/A	3.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2050	Summer	PM2.5	0.5%	#N/A	2.1%	#N/A	2.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2050	Winter	THC	-4.6%	0.1%	-2.8%	1.4%	-0.9%	0.2%	0.0%	0.0%	0.0%	0.0%	-1.5%
2050	Winter	CO	-2.3%	#N/A	-2.3%	#N/A	-2.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.2%
2050	Winter	NOX	1.9%	#N/A	3.2%	#N/A	3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	0.7%
2050	Winter	PM2.5	2.2%	#N/A	3.2%	#N/A	3.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%

Table B-41
Maricopa County (AZ) Sensitivity Scenario 5 Emission Inventory, 100% E15 (T50 Update) (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	22.943	28.310	1.336	0.643	1.707	1.935	0.506	4.009	0.159	0.657	62.205
2011	Summer	CO	489.167	0.000	36.807	0.000	22.282	0.000	9.280	19.679	0.324	1.031	578.571
2011	Summer	NOX	53.855	0.000	3.801	0.000	1.208	0.000	0.579	61.402	0.048	2.680	123.573
2011	Summer	PM2.5	0.596	0.000	0.037	0.000	0.039	0.000	0.009	2.588	0.619	0.039	3.926
2011	Winter	THC	28.949	13.608	1.405	0.341	1.726	1.271	0.545	4.323	0.170	0.694	53.031
2011	Winter	CO	426.431	0.000	35.516	0.000	24.088	0.000	7.193	20.082	0.313	1.114	514.737
2011	Winter	NOX	55.822	0.000	4.242	0.000	1.502	0.000	0.560	71.848	0.056	3.155	137.183
2011	Winter	PM2.5	1.020	0.000	0.058	0.000	0.046	0.000	0.009	2.734	0.654	0.041	4.561
2022	Summer	THC	10.200	17.592	0.503	0.500	1.423	2.192	0.174	1.198	0.011	0.760	34.553
2022	Summer	CO	360.027	0.000	22.414	0.000	20.044	0.000	5.157	6.503	0.026	1.421	415.592
2022	Summer	NOX	18.809	0.000	1.442	0.000	1.384	0.000	0.249	17.566	0.003	2.961	42.414
2022	Summer	PM2.5	0.457	0.000	0.035	0.000	0.048	0.000	0.006	0.312	0.136	0.014	1.007
2022	Winter	THC	12.846	9.611	0.515	0.293	1.409	1.530	0.258	1.426	0.012	0.802	28.700
2022	Winter	CO	296.460	0.000	20.903	0.000	21.643	0.000	3.556	6.608	0.023	1.503	350.695
2022	Winter	NOX	20.657	0.000	1.622	0.000	1.717	0.000	0.237	20.488	0.003	3.486	48.211
2022	Winter	PM2.5	0.591	0.000	0.039	0.000	0.049	0.000	0.006	0.329	0.144	0.015	1.173
2050	Summer	THC	3.826	12.486	0.391	0.623	2.223	3.384	0.071	1.690	0.001	1.416	26.112
2050	Summer	CO	201.675	0.000	19.049	0.000	31.600	0.000	3.204	9.539	0.002	2.692	267.761
2050	Summer	NOX	6.007	0.000	1.030	0.000	2.236	0.000	0.081	21.571	0.000	5.493	36.418
2050	Summer	PM2.5	0.365	0.000	0.055	0.000	0.078	0.000	0.006	0.304	0.185	0.024	1.017
2050	Winter	THC	7.822	8.555	0.414	0.400	2.193	2.430	0.231	2.075	0.001	1.494	25.615
2050	Winter	CO	183.554	0.000	19.619	0.000	34.088	0.000	2.182	9.783	0.001	2.842	252.070
2050	Winter	NOX	8.936	0.000	1.234	0.000	2.772	0.000	0.078	25.281	0.000	6.466	44.768
2050	Winter	PM2.5	0.409	0.000	0.057	0.000	0.078	0.000	0.006	0.321	0.196	0.026	1.093

Table B-42
Maricopa County (AZ) Sensitivity Scenario 5 Inventory Difference, 100% E15 (T50 Update) Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-0.603	0.067	-0.049	0.006	-0.075	0.005	0.000	0.000	0.000	0.000	-0.649
2011	Summer	CO	-30.114	0.000	-2.195	0.000	-1.362	0.000	0.000	0.000	0.000	0.000	-33.672
2011	Summer	NOX	2.398	0.000	0.146	0.000	0.041	0.000	0.000	0.000	0.000	0.000	2.585
2011	Summer	PM2.5	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.003
2011	Winter	THC	0.477	0.035	0.020	0.003	-0.002	0.003	0.000	0.000	0.000	0.000	0.535
2011	Winter	CO	-16.926	0.000	-1.359	0.000	-1.109	0.000	0.000	0.000	0.000	0.000	-19.395
2011	Winter	NOX	2.631	0.000	0.181	0.000	0.055	0.000	0.000	0.000	0.000	0.000	2.867
2011	Winter	PM2.5	0.009	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.011
2022	Summer	THC	-1.282	0.023	-0.042	0.006	-0.082	0.006	0.000	0.000	0.000	0.000	-1.371
2022	Summer	CO	-20.367	0.000	-1.249	0.000	-1.208	0.000	0.000	0.000	0.000	0.000	-22.824
2022	Summer	NOX	0.427	0.000	0.037	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.506
2022	Summer	PM2.5	0.002	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.003
2022	Winter	THC	-0.686	0.013	-0.013	0.003	-0.019	0.003	0.000	0.000	0.000	0.000	-0.698
2022	Winter	CO	-8.943	0.000	-0.624	0.000	-0.976	0.000	0.000	0.000	0.000	0.000	-10.543
2022	Winter	NOX	0.546	0.000	0.050	0.000	0.057	0.000	0.000	0.000	0.000	0.000	0.654
2022	Winter	PM2.5	0.014	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.016
2050	Summer	THC	-0.655	0.017	-0.046	0.009	-0.133	0.010	0.000	0.000	0.000	0.000	-0.798
2050	Summer	CO	-11.169	0.000	-0.995	0.000	-1.900	0.000	0.000	0.000	0.000	0.000	-14.064
2050	Summer	NOX	-0.026	0.000	0.024	0.000	0.067	0.000	0.000	0.000	0.000	0.000	0.066
2050	Summer	PM2.5	0.001	0.000	0.001	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.004
2050	Winter	THC	-0.702	0.010	-0.021	0.005	-0.033	0.005	0.000	0.000	0.000	0.000	-0.737
2050	Winter	CO	-4.757	0.000	-0.454	0.000	-1.533	0.000	0.000	0.000	0.000	0.000	-6.744
2050	Winter	NOX	-0.005	0.000	0.034	0.000	0.092	0.000	0.000	0.000	0.000	0.000	0.121
2050	Winter	PM2.5	0.012	0.000	0.002	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.017

Table B-43
Maricopa County (AZ) Sensitivity Scenario 5, Percent Inventory Impact, 100% E15 (T50 Update) Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-2.6%	0.2%	-3.5%	0.9%	-4.2%	0.3%	0.0%	0.0%	0.0%	0.0%	-1.0%
2011	Summer	CO	-5.8%	#N/A	-5.6%	#N/A	-5.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.5%
2011	Summer	NOX	4.7%	#N/A	4.0%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	2.1%
2011	Summer	PM2.5	0.3%	#N/A	1.0%	#N/A	2.2%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2011	Winter	THC	1.7%	0.3%	1.4%	0.9%	-0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	1.0%
2011	Winter	CO	-3.8%	#N/A	-3.7%	#N/A	-4.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.6%
2011	Winter	NOX	4.9%	#N/A	4.5%	#N/A	3.8%	#N/A	0.0%	0.0%	0.0%	0.0%	2.1%
2011	Winter	PM2.5	0.9%	#N/A	1.3%	#N/A	2.9%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2022	Summer	THC	-11.2%	0.1%	-7.7%	1.2%	-5.4%	0.3%	0.0%	0.0%	0.0%	0.0%	-3.8%
2022	Summer	CO	-5.4%	#N/A	-5.3%	#N/A	-5.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.2%
2022	Summer	NOX	2.3%	#N/A	2.6%	#N/A	3.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%
2022	Summer	PM2.5	0.4%	#N/A	1.9%	#N/A	2.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2022	Winter	THC	-5.1%	0.1%	-2.4%	1.2%	-1.3%	0.2%	0.0%	0.0%	0.0%	0.0%	-2.4%
2022	Winter	CO	-2.9%	#N/A	-2.9%	#N/A	-4.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.9%
2022	Winter	NOX	2.7%	#N/A	3.2%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.4%
2022	Winter	PM2.5	2.3%	#N/A	3.0%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.4%
2050	Summer	THC	-14.6%	0.1%	-10.4%	1.5%	-5.6%	0.3%	0.0%	0.0%	0.0%	0.0%	-3.0%
2050	Summer	CO	-5.2%	#N/A	-5.0%	#N/A	-5.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.0%
2050	Summer	NOX	-0.4%	#N/A	2.4%	#N/A	3.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2050	Summer	PM2.5	0.4%	#N/A	2.0%	#N/A	2.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2050	Winter	THC	-8.2%	0.1%	-4.9%	1.4%	-1.5%	0.2%	0.0%	0.0%	0.0%	0.0%	-2.8%
2050	Winter	CO	-2.5%	#N/A	-2.3%	#N/A	-4.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.6%
2050	Winter	NOX	-0.1%	#N/A	2.9%	#N/A	3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2050	Winter	PM2.5	3.2%	#N/A	3.5%	#N/A	3.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.6%

Table B-44
Maricopa County (AZ) Sensitivity Scenario 6 Emission Inventory, Remove LD I/M (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	33.684	28.243	1.385	0.637	1.783	1.930	0.506	4.009	0.159	0.657	72.993
2011	Summer	CO	659.590	0.000	39.002	0.000	23.645	0.000	9.280	19.679	0.324	1.031	752.551
2011	Summer	NOX	63.360	0.000	3.655	0.000	1.167	0.000	0.579	61.402	0.048	2.680	132.891
2011	Summer	PM2.5	0.594	0.000	0.036	0.000	0.038	0.000	0.009	2.588	0.619	0.039	3.923
2011	Winter	THC	38.021	13.573	1.385	0.338	1.728	1.268	0.545	4.323	0.170	0.694	62.044
2011	Winter	CO	548.816	0.000	36.875	0.000	25.197	0.000	7.193	20.082	0.313	1.114	639.591
2011	Winter	NOX	65.222	0.000	4.060	0.000	1.447	0.000	0.560	71.848	0.056	3.155	146.347
2011	Winter	PM2.5	1.011	0.000	0.057	0.000	0.045	0.000	0.009	2.734	0.654	0.041	4.550
2022	Summer	THC	16.120	17.568	0.545	0.495	1.505	2.186	0.174	1.198	0.011	0.760	40.561
2022	Summer	CO	470.648	0.000	23.663	0.000	21.252	0.000	5.157	6.503	0.026	1.421	528.670
2022	Summer	NOX	23.289	0.000	1.405	0.000	1.342	0.000	0.249	17.566	0.003	2.961	46.815
2022	Summer	PM2.5	0.456	0.000	0.034	0.000	0.047	0.000	0.006	0.312	0.136	0.014	1.004
2022	Winter	THC	17.711	9.598	0.528	0.289	1.428	1.527	0.258	1.426	0.012	0.802	33.577
2022	Winter	CO	369.155	0.000	21.526	0.000	22.620	0.000	3.556	6.608	0.023	1.503	424.990
2022	Winter	NOX	25.000	0.000	1.572	0.000	1.660	0.000	0.237	20.488	0.003	3.486	52.446
2022	Winter	PM2.5	0.578	0.000	0.038	0.000	0.047	0.000	0.006	0.329	0.144	0.015	1.156
2050	Summer	THC	5.559	12.469	0.437	0.614	2.356	3.375	0.071	1.690	0.001	1.416	27.988
2050	Summer	CO	251.446	0.000	20.044	0.000	33.500	0.000	3.204	9.539	0.002	2.692	320.427
2050	Summer	NOX	7.032	0.000	1.006	0.000	2.169	0.000	0.081	21.571	0.000	5.493	37.353
2050	Summer	PM2.5	0.363	0.000	0.054	0.000	0.076	0.000	0.006	0.304	0.185	0.024	1.013
2050	Winter	THC	9.428	8.545	0.436	0.394	2.226	2.425	0.231	2.075	0.001	1.494	27.256
2050	Winter	CO	215.123	0.000	20.073	0.000	35.621	0.000	2.182	9.783	0.001	2.842	285.625
2050	Winter	NOX	9.915	0.000	1.200	0.000	2.681	0.000	0.078	25.281	0.000	6.466	45.620
2050	Winter	PM2.5	0.397	0.000	0.055	0.000	0.076	0.000	0.006	0.321	0.196	0.026	1.076

Table B-45
Maricopa County (AZ) Sensitivity Scenario 6 Inventory Difference, Remove LD I/M Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	10.139	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.139
2011	Summer	CO	140.308	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	140.308
2011	Summer	NOX	11.903	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	11.903
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC	9.548	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9.548
2011	Winter	CO	105.459	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	105.459
2011	Winter	NOX	12.030	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.030
2011	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	THC	4.638	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.638
2022	Summer	CO	90.254	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	90.254
2022	Summer	NOX	4.907	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.907
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC	4.180	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.180
2022	Winter	CO	63.752	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	63.752
2022	Winter	NOX	4.889	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.889
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	THC	1.078	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.078
2050	Summer	CO	38.602	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	38.602
2050	Summer	NOX	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC	0.904	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.904
2050	Winter	CO	26.812	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26.812
2050	Winter	NOX	0.974	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.974
2050	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B-46
Maricopa County (AZ) Sensitivity Scenario 6, Percent Inventory Impact, Remove LD I/M Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	43.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	16.1%
2011	Summer	CO	27.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	22.9%
2011	Summer	NOX	23.1%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	9.8%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC	33.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	18.2%
2011	Winter	CO	23.8%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	19.7%
2011	Winter	NOX	22.6%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	9.0%
2011	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	THC	40.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.9%
2022	Summer	CO	23.7%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	20.6%
2022	Summer	NOX	26.7%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	11.7%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC	30.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	14.2%
2022	Winter	CO	20.9%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	17.6%
2022	Winter	NOX	24.3%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	10.3%
2022	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	THC	24.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%
2050	Summer	CO	18.1%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	13.7%
2050	Summer	NOX	16.6%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	2.8%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC	10.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.4%
2050	Winter	CO	14.2%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	10.4%
2050	Winter	NOX	10.9%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	2.2%
2050	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%

Table B-47
Maricopa County (AZ) Scenario 7 Emission Inventory, Add SCR Start-Up (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	23.545	28.243	1.385	0.637	1.783	1.930	0.506	4.009	0.159	0.657	62.854
2011	Summer	CO	519.282	0.000	39.002	0.000	23.645	0.000	9.280	19.679	0.324	1.031	612.243
2011	Summer	NOX	51.457	0.000	3.655	0.000	1.167	0.000	0.579	61.525	0.048	2.680	121.110
2011	Summer	PM2.5	0.594	0.000	0.036	0.000	0.038	0.000	0.009	2.588	0.619	0.039	3.923
2011	Winter	THC	28.473	13.573	1.385	0.338	1.728	1.268	0.545	4.323	0.170	0.694	52.496
2011	Winter	CO	443.357	0.000	36.875	0.000	25.197	0.000	7.193	20.082	0.313	1.114	534.132
2011	Winter	NOX	53.191	0.000	4.060	0.000	1.447	0.000	0.560	71.970	0.056	3.155	134.439
2011	Winter	PM2.5	1.011	0.000	0.057	0.000	0.045	0.000	0.009	2.734	0.654	0.041	4.550
2022	Summer	THC	11.483	17.568	0.545	0.495	1.505	2.186	0.174	1.198	0.011	0.760	35.923
2022	Summer	CO	380.394	0.000	23.663	0.000	21.252	0.000	5.157	6.503	0.026	1.421	438.416
2022	Summer	NOX	18.382	0.000	1.405	0.000	1.342	0.000	0.249	18.926	0.003	2.961	43.268
2022	Summer	PM2.5	0.456	0.000	0.034	0.000	0.047	0.000	0.006	0.312	0.136	0.014	1.004
2022	Winter	THC	13.531	9.598	0.528	0.289	1.428	1.527	0.258	1.426	0.012	0.802	29.397
2022	Winter	CO	305.402	0.000	21.526	0.000	22.620	0.000	3.556	6.608	0.023	1.503	361.238
2022	Winter	NOX	20.111	0.000	1.572	0.000	1.660	0.000	0.237	21.848	0.003	3.486	48.917
2022	Winter	PM2.5	0.578	0.000	0.038	0.000	0.047	0.000	0.006	0.329	0.144	0.015	1.156
2050	Summer	THC	4.481	12.469	0.437	0.614	2.356	3.375	0.071	1.690	0.001	1.416	26.910
2050	Summer	CO	212.844	0.000	20.044	0.000	33.500	0.000	3.204	9.539	0.002	2.692	281.825
2050	Summer	NOX	6.032	0.000	1.006	0.000	2.169	0.000	0.081	24.523	0.000	5.493	39.305
2050	Summer	PM2.5	0.363	0.000	0.054	0.000	0.076	0.000	0.006	0.304	0.185	0.024	1.013
2050	Winter	THC	8.524	8.545	0.436	0.394	2.226	2.425	0.231	2.075	0.001	1.494	26.352
2050	Winter	CO	188.311	0.000	20.073	0.000	35.621	0.000	2.182	9.783	0.001	2.842	258.814
2050	Winter	NOX	8.941	0.000	1.200	0.000	2.681	0.000	0.078	28.233	0.000	6.466	47.599
2050	Winter	PM2.5	0.397	0.000	0.055	0.000	0.076	0.000	0.006	0.321	0.196	0.026	1.076

Table B-48
Maricopa County (AZ) Scenario 7 Inventory Difference, Add SCR Start-Up Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.123	0.000	0.000	0.123
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.123	0.000	0.000	0.123
2011	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.360	0.000	0.000	1.360
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.360	0.000	0.000	1.360
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.952	0.000	0.000	2.952
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.952	0.000	0.000	2.952
2050	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B-49
Maricopa County (AZ) Scenario 7, Percent Inventory Impact, Add SCR Start-Up Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.2%	0.0%	0.0%	0.1%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.2%	0.0%	0.0%	0.1%
2011	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	7.7%	0.0%	0.0%	3.2%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	6.6%	0.0%	0.0%	2.9%
2022	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	13.7%	0.0%	0.0%	8.1%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	11.7%	0.0%	0.0%	6.6%
2050	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%

Table B-50
Maricopa County (AZ) Sensitivity Scenario 8 Emission Inventory, Conventional Gasoline (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	24.732	34.527	1.584	0.765	1.731	2.498	0.506	4.009	0.159	0.657	71.169
2011	Summer	CO	548.987	0.000	42.182	0.000	26.261	0.000	9.280	19.679	0.324	1.031	647.744
2011	Summer	NOX	61.371	0.000	5.555	0.000	1.195	0.000	0.579	61.402	0.048	2.680	132.831
2011	Summer	PM2.5	0.639	0.000	0.039	0.000	0.044	0.000	0.009	2.588	0.619	0.039	3.976
2011	Winter	THC	29.802	13.573	1.611	0.338	1.796	1.268	0.545	4.323	0.170	0.694	54.121
2011	Winter	CO	436.871	0.000	37.991	0.000	26.077	0.000	7.193	20.082	0.313	1.114	529.641
2011	Winter	NOX	60.616	0.000	6.042	0.000	1.454	0.000	0.560	71.848	0.056	3.155	143.730
2011	Winter	PM2.5	1.057	0.000	0.060	0.000	0.049	0.000	0.009	2.734	0.654	0.041	4.603
2022	Summer	THC	10.763	20.825	0.522	0.614	1.430	2.908	0.174	1.198	0.011	0.760	39.205
2022	Summer	CO	396.156	0.000	23.990	0.000	23.584	0.000	5.157	6.503	0.026	1.421	456.837
2022	Summer	NOX	19.290	0.000	1.491	0.000	1.360	0.000	0.249	17.566	0.003	2.961	42.920
2022	Summer	PM2.5	0.525	0.000	0.039	0.000	0.054	0.000	0.006	0.312	0.136	0.014	1.085
2022	Winter	THC	13.423	9.598	0.538	0.289	1.472	1.527	0.258	1.426	0.012	0.802	29.343
2022	Winter	CO	293.637	0.000	20.686	0.000	23.176	0.000	3.556	6.608	0.023	1.503	349.189
2022	Winter	NOX	20.289	0.000	1.630	0.000	1.655	0.000	0.237	20.488	0.003	3.486	47.789
2022	Winter	PM2.5	0.631	0.000	0.041	0.000	0.051	0.000	0.006	0.329	0.144	0.015	1.217
2050	Summer	THC	4.085	15.507	0.410	0.798	2.234	4.550	0.071	1.690	0.001	1.416	30.763
2050	Summer	CO	222.819	0.000	19.544	0.000	37.218	0.000	3.204	9.539	0.002	2.692	295.018
2050	Summer	NOX	6.209	0.000	1.071	0.000	2.196	0.000	0.081	21.571	0.000	5.493	36.622
2050	Summer	PM2.5	0.430	0.000	0.063	0.000	0.087	0.000	0.006	0.304	0.185	0.024	1.099
2050	Winter	THC	8.399	8.545	0.444	0.394	2.296	2.425	0.231	2.075	0.001	1.494	26.305
2050	Winter	CO	179.186	0.000	18.886	0.000	36.519	0.000	2.182	9.783	0.001	2.842	249.400
2050	Winter	NOX	8.885	0.000	1.255	0.000	2.673	0.000	0.078	25.281	0.000	6.466	44.638
2050	Winter	PM2.5	0.446	0.000	0.060	0.000	0.082	0.000	0.006	0.321	0.196	0.026	1.137

Table B-51
Maricopa County (AZ) Sensitivity Scenario 8 Inventory Difference, Conventional Gasoline Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	1.186	6.284	0.199	0.128	-0.052	0.568	0.000	0.000	0.000	0.000	8.314
2011	Summer	CO	29.705	0.000	3.180	0.000	2.616	0.000	0.000	0.000	0.000	0.000	35.501
2011	Summer	NOX	9.915	0.000	1.900	0.000	0.028	0.000	0.000	0.000	0.000	0.000	11.843
2011	Summer	PM2.5	0.044	0.000	0.003	0.000	0.006	0.000	0.000	0.000	0.000	0.000	0.053
2011	Winter	THC	1.330	0.000	0.226	0.000	0.068	0.000	0.000	0.000	0.000	0.000	1.625
2011	Winter	CO	-6.486	0.000	1.115	0.000	0.881	0.000	0.000	0.000	0.000	0.000	-4.490
2011	Winter	NOX	7.425	0.000	1.982	0.000	0.006	0.000	0.000	0.000	0.000	0.000	9.414
2011	Winter	PM2.5	0.046	0.000	0.003	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.053
2022	Summer	THC	-0.719	3.257	-0.022	0.119	-0.075	0.722	0.000	0.000	0.000	0.000	3.282
2022	Summer	CO	15.762	0.000	0.327	0.000	2.332	0.000	0.000	0.000	0.000	0.000	18.420
2022	Summer	NOX	0.908	0.000	0.086	0.000	0.018	0.000	0.000	0.000	0.000	0.000	1.013
2022	Summer	PM2.5	0.070	0.000	0.005	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.082
2022	Winter	THC	-0.108	0.000	0.010	0.000	0.044	0.000	0.000	0.000	0.000	0.000	-0.054
2022	Winter	CO	-11.765	0.000	-0.840	0.000	0.556	0.000	0.000	0.000	0.000	0.000	-12.049
2022	Winter	NOX	0.178	0.000	0.059	0.000	-0.004	0.000	0.000	0.000	0.000	0.000	0.232
2022	Winter	PM2.5	0.054	0.000	0.003	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.061
2050	Summer	THC	-0.396	3.037	-0.027	0.184	-0.121	1.176	0.000	0.000	0.000	0.000	3.853
2050	Summer	CO	9.975	0.000	-0.500	0.000	3.718	0.000	0.000	0.000	0.000	0.000	13.193
2050	Summer	NOX	0.177	0.000	0.065	0.000	0.027	0.000	0.000	0.000	0.000	0.000	0.269
2050	Summer	PM2.5	0.067	0.000	0.009	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.087
2050	Winter	THC	-0.125	0.000	0.008	0.000	0.070	0.000	0.000	0.000	0.000	0.000	-0.047
2050	Winter	CO	-9.125	0.000	-1.187	0.000	0.899	0.000	0.000	0.000	0.000	0.000	-9.413
2050	Winter	NOX	-0.056	0.000	0.055	0.000	-0.008	0.000	0.000	0.000	0.000	0.000	-0.008
2050	Winter	PM2.5	0.049	0.000	0.005	0.000	0.007	0.000	0.000	0.000	0.000	0.000	0.062

Table B-52
Maricopa County (AZ) Sensitivity Scenario 8, Percent Inventory Impact, Conventional Gasoline Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	5.0%	22.3%	14.4%	20.1%	-2.9%	29.4%	0.0%	0.0%	0.0%	0.0%	13.2%
2011	Summer	CO	5.7%	#N/A	8.2%	#N/A	11.1%	#N/A	0.0%	0.0%	0.0%	0.0%	5.8%
2011	Summer	NOX	19.3%	#N/A	52.0%	#N/A	2.4%	#N/A	0.0%	0.0%	0.0%	0.0%	9.8%
2011	Summer	PM2.5	7.5%	#N/A	8.2%	#N/A	14.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.3%
2011	Winter	THC	4.7%	0.0%	16.4%	0.0%	3.9%	0.0%	0.0%	0.0%	0.0%	0.0%	3.1%
2011	Winter	CO	-1.5%	#N/A	3.0%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.8%
2011	Winter	NOX	14.0%	#N/A	48.8%	#N/A	0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	7.0%
2011	Winter	PM2.5	4.5%	#N/A	4.7%	#N/A	9.4%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%
2022	Summer	THC	-6.3%	18.5%	-4.1%	24.1%	-5.0%	33.0%	0.0%	0.0%	0.0%	0.0%	9.1%
2022	Summer	CO	4.1%	#N/A	1.4%	#N/A	11.0%	#N/A	0.0%	0.0%	0.0%	0.0%	4.2%
2022	Summer	NOX	4.9%	#N/A	6.1%	#N/A	1.3%	#N/A	0.0%	0.0%	0.0%	0.0%	2.4%
2022	Summer	PM2.5	15.3%	#N/A	14.6%	#N/A	14.8%	#N/A	0.0%	0.0%	0.0%	0.0%	8.1%
2022	Winter	THC	-0.8%	0.0%	1.9%	0.0%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%
2022	Winter	CO	-3.9%	#N/A	-3.9%	#N/A	2.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.3%
2022	Winter	NOX	0.9%	#N/A	3.7%	#N/A	-0.3%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2022	Winter	PM2.5	9.3%	#N/A	8.5%	#N/A	8.7%	#N/A	0.0%	0.0%	0.0%	0.0%	5.3%
2050	Summer	THC	-8.8%	24.4%	-6.1%	30.0%	-5.2%	34.8%	0.0%	0.0%	0.0%	0.0%	14.3%
2050	Summer	CO	4.7%	#N/A	-2.5%	#N/A	11.1%	#N/A	0.0%	0.0%	0.0%	0.0%	4.7%
2050	Summer	NOX	2.9%	#N/A	6.5%	#N/A	1.3%	#N/A	0.0%	0.0%	0.0%	0.0%	0.7%
2050	Summer	PM2.5	18.4%	#N/A	15.8%	#N/A	15.0%	#N/A	0.0%	0.0%	0.0%	0.0%	8.6%
2050	Winter	THC	-1.5%	0.0%	1.9%	0.0%	3.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%
2050	Winter	CO	-4.8%	#N/A	-5.9%	#N/A	2.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.6%
2050	Winter	NOX	-0.6%	#N/A	4.6%	#N/A	-0.3%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	PM2.5	12.5%	#N/A	9.8%	#N/A	8.9%	#N/A	0.0%	0.0%	0.0%	0.0%	5.7%

Table B-53
Maricopa County (AZ) Sensitivity Scenario 9 Emission Inventory, National LDA/LDT Mix (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	24.636	31.860	1.385	0.637	1.783	1.930	0.314	4.009	0.040	0.816	67.410
2011	Summer	CO	540.999	0.000	39.002	0.000	23.645	0.000	5.858	19.679	0.067	1.355	630.604
2011	Summer	NOX	53.104	0.000	3.655	0.000	1.167	0.000	0.410	61.402	0.000	2.728	122.466
2011	Summer	PM2.5	0.650	0.000	0.036	0.000	0.038	0.000	0.005	2.588	0.171	0.657	4.146
2011	Winter	THC	30.419	15.380	1.385	0.338	1.728	1.268	0.338	4.323	0.038	0.863	56.080
2011	Winter	CO	464.757	0.000	36.875	0.000	25.197	0.000	4.500	20.082	0.058	1.427	552.896
2011	Winter	NOX	54.939	0.000	4.060	0.000	1.447	0.000	0.396	71.848	0.000	3.211	135.900
2011	Winter	PM2.5	1.105	0.000	0.057	0.000	0.045	0.000	0.005	2.734	0.152	0.695	4.792
2022	Summer	THC	12.676	20.036	0.545	0.495	1.505	2.186	0.121	1.198	0.006	0.770	39.538
2022	Summer	CO	414.585	0.000	23.663	0.000	21.252	0.000	3.445	6.503	0.010	1.447	470.905
2022	Summer	NOX	18.607	0.000	1.405	0.000	1.342	0.000	0.188	17.566	0.000	2.964	42.072
2022	Summer	PM2.5	0.493	0.000	0.034	0.000	0.047	0.000	0.004	0.312	0.036	0.150	1.076
2022	Winter	THC	15.099	11.013	0.528	0.289	1.428	1.527	0.170	1.426	0.006	0.814	32.299
2022	Winter	CO	335.867	0.000	21.526	0.000	22.620	0.000	2.381	6.608	0.009	1.526	390.536
2022	Winter	NOX	20.597	0.000	1.572	0.000	1.660	0.000	0.179	20.488	0.000	3.489	47.985
2022	Winter	PM2.5	0.625	0.000	0.038	0.000	0.047	0.000	0.004	0.329	0.033	0.158	1.234
2050	Summer	THC	5.180	14.488	0.437	0.614	2.356	3.375	0.041	1.690	0.000	1.417	29.598
2050	Summer	CO	241.965	0.000	20.044	0.000	33.500	0.000	1.886	9.539	0.000	2.694	309.628
2050	Summer	NOX	6.817	0.000	1.006	0.000	2.169	0.000	0.048	21.571	0.000	5.493	37.104
2050	Summer	PM2.5	0.394	0.000	0.054	0.000	0.076	0.000	0.004	0.304	0.014	0.210	1.056
2050	Winter	THC	9.920	9.908	0.436	0.394	2.226	2.425	0.132	2.075	0.000	1.495	29.012
2050	Winter	CO	215.804	0.000	20.073	0.000	35.621	0.000	1.283	9.783	0.000	2.843	285.407
2050	Winter	NOX	10.214	0.000	1.200	0.000	2.681	0.000	0.046	25.281	0.000	6.466	45.887
2050	Winter	PM2.5	0.431	0.000	0.055	0.000	0.076	0.000	0.004	0.321	0.008	0.221	1.116

Table B-54
Maricopa County (AZ) Sensitivity Scenario 9 Inventory Difference, National LDA/LDT Mix Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	1.090	3.618	0.000	0.000	0.000	0.000	-0.193	0.000	-0.120	0.159	4.555
2011	Summer	CO	21.717	0.000	0.000	0.000	0.000	0.000	-3.422	0.000	-0.257	0.324	18.362
2011	Summer	NOX	1.647	0.000	0.000	0.000	0.000	0.000	-0.169	0.000	-0.048	0.048	1.478
2011	Summer	PM2.5	0.055	0.000	0.000	0.000	0.000	0.000	-0.004	0.000	-0.447	0.619	0.223
2011	Winter	THC	1.946	1.807	0.000	0.000	0.000	0.000	-0.206	0.000	-0.132	0.170	3.584
2011	Winter	CO	21.400	0.000	0.000	0.000	0.000	0.000	-2.693	0.000	-0.255	0.313	18.765
2011	Winter	NOX	1.747	0.000	0.000	0.000	0.000	0.000	-0.164	0.000	-0.056	0.056	1.583
2011	Winter	PM2.5	0.094	0.000	0.000	0.000	0.000	0.000	-0.004	0.000	-0.502	0.654	0.242
2022	Summer	THC	1.193	2.468	0.000	0.000	0.000	0.000	-0.053	0.000	-0.005	0.011	3.614
2022	Summer	CO	34.191	0.000	0.000	0.000	0.000	0.000	-1.712	0.000	-0.016	0.026	32.488
2022	Summer	NOX	0.225	0.000	0.000	0.000	0.000	0.000	-0.061	0.000	-0.003	0.003	0.164
2022	Summer	PM2.5	0.037	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	-0.099	0.136	0.072
2022	Winter	THC	1.568	1.415	0.000	0.000	0.000	0.000	-0.088	0.000	-0.006	0.012	2.901
2022	Winter	CO	30.464	0.000	0.000	0.000	0.000	0.000	-1.174	0.000	-0.014	0.023	29.299
2022	Winter	NOX	0.487	0.000	0.000	0.000	0.000	0.000	-0.058	0.000	-0.003	0.003	0.429
2022	Winter	PM2.5	0.047	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	-0.111	0.144	0.078
2050	Summer	THC	0.699	2.019	0.000	0.000	0.000	0.000	-0.030	0.000	-0.001	0.001	2.688
2050	Summer	CO	29.121	0.000	0.000	0.000	0.000	0.000	-1.319	0.000	-0.002	0.002	27.803
2050	Summer	NOX	0.785	0.000	0.000	0.000	0.000	0.000	-0.033	0.000	0.000	0.000	0.751
2050	Summer	PM2.5	0.031	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	-0.171	0.185	0.043
2050	Winter	THC	1.396	1.362	0.000	0.000	0.000	0.000	-0.099	0.000	-0.001	0.001	2.660
2050	Winter	CO	27.493	0.000	0.000	0.000	0.000	0.000	-0.900	0.000	-0.001	0.001	26.594
2050	Winter	NOX	1.273	0.000	0.000	0.000	0.000	0.000	-0.032	0.000	0.000	0.000	1.241
2050	Winter	PM2.5	0.034	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	-0.187	0.196	0.040

Table B-55
Maricopa County (AZ) Sensitivity Scenario 9, Percent Inventory Impact, National LDA/LDT Mix Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	4.6%	12.8%	0.0%	0.0%	0.0%	0.0%	-38.0%	0.0%	-75.0%	24.3%	7.2%
2011	Summer	CO	4.2%	#N/A	0.0%	#N/A	0.0%	#N/A	-36.9%	0.0%	-79.4%	31.4%	3.0%
2011	Summer	NOX	3.2%	#N/A	0.0%	#N/A	0.0%	#N/A	-29.2%	0.0%	-100.0%	1.8%	1.2%
2011	Summer	PM2.5	9.3%	#N/A	0.0%	#N/A	0.0%	#N/A	-43.1%	0.0%	-72.3%	1590.7%	5.7%
2011	Winter	THC	6.8%	13.3%	0.0%	0.0%	0.0%	0.0%	-37.9%	0.0%	-77.8%	24.5%	6.8%
2011	Winter	CO	4.8%	#N/A	0.0%	#N/A	0.0%	#N/A	-37.4%	0.0%	-81.4%	28.1%	3.5%
2011	Winter	NOX	3.3%	#N/A	0.0%	#N/A	0.0%	#N/A	-29.3%	0.0%	-100.0%	1.8%	1.2%
2011	Winter	PM2.5	9.3%	#N/A	0.0%	#N/A	0.0%	#N/A	-43.1%	0.0%	-76.7%	1592.0%	5.3%
2022	Summer	THC	10.4%	14.0%	0.0%	0.0%	0.0%	0.0%	-30.3%	0.0%	-48.6%	1.4%	10.1%
2022	Summer	CO	9.0%	#N/A	0.0%	#N/A	0.0%	#N/A	-33.2%	0.0%	-63.0%	1.8%	7.4%
2022	Summer	NOX	1.2%	#N/A	0.0%	#N/A	0.0%	#N/A	-24.6%	0.0%	-100.0%	0.1%	0.4%
2022	Summer	PM2.5	8.2%	#N/A	0.0%	#N/A	0.0%	#N/A	-34.0%	0.0%	-73.2%	967.8%	7.2%
2022	Winter	THC	11.6%	14.7%	0.0%	0.0%	0.0%	0.0%	-34.1%	0.0%	-51.5%	1.5%	9.9%
2022	Winter	CO	10.0%	#N/A	0.0%	#N/A	0.0%	#N/A	-33.0%	0.0%	-62.5%	1.5%	8.1%
2022	Winter	NOX	2.4%	#N/A	0.0%	#N/A	0.0%	#N/A	-24.4%	0.0%	-100.0%	0.1%	0.9%
2022	Winter	PM2.5	8.1%	#N/A	0.0%	#N/A	0.0%	#N/A	-34.0%	0.0%	-77.3%	968.5%	6.7%
2050	Summer	THC	15.6%	16.2%	0.0%	0.0%	0.0%	0.0%	-42.1%	0.0%	-56.1%	0.1%	10.0%
2050	Summer	CO	13.7%	#N/A	0.0%	#N/A	0.0%	#N/A	-41.2%	0.0%	-92.0%	0.1%	9.9%
2050	Summer	NOX	13.0%	#N/A	0.0%	#N/A	0.0%	#N/A	-40.7%	0.0%	-100.0%	0.0%	2.1%
2050	Summer	PM2.5	8.5%	#N/A	0.0%	#N/A	0.0%	#N/A	-38.2%	0.0%	-92.3%	762.4%	4.2%
2050	Winter	THC	16.4%	15.9%	0.0%	0.0%	0.0%	0.0%	-42.8%	0.0%	-69.0%	0.1%	10.1%
2050	Winter	CO	14.6%	#N/A	0.0%	#N/A	0.0%	#N/A	-41.2%	0.0%	-92.8%	0.0%	10.3%
2050	Winter	NOX	14.2%	#N/A	0.0%	#N/A	0.0%	#N/A	-40.8%	0.0%	-100.0%	0.0%	2.8%
2050	Winter	PM2.5	8.6%	#N/A	0.0%	#N/A	0.0%	#N/A	-38.2%	0.0%	-95.7%	763.0%	3.7%

Table B-56
Wayne County (MI) Sensitivity Scenario 1 Emission Inventory, +1 PSI RVP (Fuel Wizard) (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	17.384	10.467	1.172	0.537	0.678	0.728	0.208	2.980	0.125	0.781	35.058
2011	Summer	CO	311.557	0.000	29.436	0.000	10.211	0.000	3.681	13.699	0.208	1.253	370.046
2011	Summer	NOX	35.522	0.000	3.536	0.000	0.415	0.000	0.256	38.064	0.034	2.893	80.720
2011	Summer	PM2.5	0.328	0.000	0.028	0.000	0.016	0.000	0.004	1.674	0.435	0.056	2.541
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	4.938	4.719	0.292	0.326	0.426	0.686	0.046	0.793	0.014	0.649	12.889
2022	Summer	CO	163.761	0.000	11.624	0.000	7.034	0.000	1.438	3.509	0.019	1.211	188.595
2022	Summer	NOX	7.432	0.000	0.778	0.000	0.371	0.000	0.064	9.106	0.003	2.354	20.108
2022	Summer	PM2.5	0.227	0.000	0.019	0.000	0.015	0.000	0.002	0.223	0.086	0.014	0.586
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	1.165	2.536	0.122	0.272	0.398	0.642	0.014	0.538	0.001	0.729	6.417
2050	Summer	CO	56.795	0.000	4.675	0.000	6.711	0.000	0.606	2.499	0.001	1.386	72.672
2050	Summer	NOX	1.647	0.000	0.280	0.000	0.372	0.000	0.016	5.250	0.000	2.624	10.190
2050	Summer	PM2.5	0.126	0.000	0.018	0.000	0.016	0.000	0.001	0.075	0.046	0.013	0.294
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-57
Wayne County (MI) Sensitivity Scenario 1 Inventory Difference, +1 PSI RVP (Fuel Wizard) Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-0.239	0.571	-0.023	0.045	-0.019	0.049	0.000	0.000	0.000	0.000	0.384
2011	Summer	CO	2.170	0.000	0.206	0.000	0.096	0.000	0.000	0.000	0.000	0.000	2.472
2011	Summer	NOX	0.247	0.000	0.018	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.265
2011	Summer	PM2.5	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	-0.168	0.127	-0.008	0.028	-0.014	0.047	0.000	0.000	0.000	0.000	0.011
2022	Summer	CO	1.688	0.000	0.112	0.000	0.073	0.000	0.000	0.000	0.000	0.000	1.873
2022	Summer	NOX	0.017	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019
2022	Summer	PM2.5	-0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.004
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	-0.051	0.049	-0.005	0.025	-0.014	0.049	0.000	0.000	0.000	0.000	0.052
2050	Summer	CO	0.627	0.000	0.054	0.000	0.074	0.000	0.000	0.000	0.000	0.000	0.755
2050	Summer	NOX	-0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003
2050	Summer	PM2.5	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-58
Wayne County (MI) Sensitivity Scenario 1, Percent Inventory Impact, +1 PSI RVP (Fuel Wizard) Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-1.4%	5.8%	-1.9%	9.2%	-2.7%	7.2%	0.0%	0.0%	0.0%	0.0%	1.1%
2011	Summer	CO	0.7%	#N/A	0.7%	#N/A	1.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.7%
2011	Summer	NOX	0.7%	#N/A	0.5%	#N/A	0.2%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Summer	PM2.5	-0.9%	#N/A	-0.6%	#N/A	-1.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	-3.3%	2.8%	-2.8%	9.4%	-3.2%	7.4%	0.0%	0.0%	0.0%	0.0%	0.1%
2022	Summer	CO	1.0%	#N/A	1.0%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Summer	NOX	0.2%	#N/A	0.3%	#N/A	0.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2022	Summer	PM2.5	-1.6%	#N/A	-1.2%	#N/A	-1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.7%
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	-4.2%	2.0%	-3.8%	10.2%	-3.5%	8.2%	0.0%	0.0%	0.0%	0.0%	0.8%
2050	Summer	CO	1.1%	#N/A	1.2%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2050	Summer	NOX	-0.2%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	PM2.5	-1.8%	#N/A	-1.4%	#N/A	-1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.9%
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-59
Wayne County (MI) Sensitivity Scenario 2 Emission Inventory, +1 PSI RVP (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	17.661	10.467	1.190	0.537	0.688	0.728	0.208	2.980	0.125	0.781	35.363
2011	Summer	CO	312.543	0.000	29.517	0.000	10.277	0.000	3.681	13.699	0.208	1.253	371.179
2011	Summer	NOX	35.537	0.000	3.537	0.000	0.415	0.000	0.256	38.064	0.034	2.893	80.735
2011	Summer	PM2.5	0.331	0.000	0.028	0.000	0.016	0.000	0.004	1.674	0.435	0.056	2.544
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	5.023	4.719	0.296	0.326	0.432	0.686	0.046	0.793	0.014	0.649	12.983
2022	Summer	CO	164.258	0.000	11.656	0.000	7.082	0.000	1.438	3.509	0.019	1.211	189.173
2022	Summer	NOX	7.441	0.000	0.778	0.000	0.371	0.000	0.064	9.106	0.003	2.354	20.117
2022	Summer	PM2.5	0.231	0.000	0.019	0.000	0.015	0.000	0.002	0.223	0.086	0.014	0.591
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	1.186	2.536	0.124	0.272	0.403	0.642	0.014	0.538	0.001	0.729	6.445
2050	Summer	CO	56.970	0.000	4.675	0.000	6.759	0.000	0.606	2.499	0.001	1.386	72.895
2050	Summer	NOX	1.651	0.000	0.280	0.000	0.372	0.000	0.016	5.250	0.000	2.624	10.193
2050	Summer	PM2.5	0.129	0.000	0.018	0.000	0.016	0.000	0.001	0.075	0.046	0.013	0.297
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-60
Wayne County (MI) Sensitivity Scenario 2 Inventory Difference, +1 PSI RVP Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.038	0.571	-0.004	0.045	-0.009	0.049	0.000	0.000	0.000	0.000	0.690
2011	Summer	CO	3.156	0.000	0.287	0.000	0.162	0.000	0.000	0.000	0.000	0.000	3.605
2011	Summer	NOX	0.262	0.000	0.019	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.281
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	-0.084	0.127	-0.004	0.028	-0.008	0.047	0.000	0.000	0.000	0.000	0.106
2022	Summer	CO	2.186	0.000	0.143	0.000	0.122	0.000	0.000	0.000	0.000	0.000	2.451
2022	Summer	NOX	0.025	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.028
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	-0.031	0.049	-0.003	0.025	-0.009	0.049	0.000	0.000	0.000	0.000	0.079
2050	Summer	CO	0.802	0.000	0.054	0.000	0.122	0.000	0.000	0.000	0.000	0.000	0.978
2050	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-61
Wayne County (MI) Sensitivity Scenario 2, Percent Inventory Impact, +1 PSI RVP Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.2%	5.8%	-0.4%	9.2%	-1.3%	7.2%	0.0%	0.0%	0.0%	0.0%	2.0%
2011	Summer	CO	1.0%	#N/A	1.0%	#N/A	1.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2011	Summer	NOX	0.7%	#N/A	0.5%	#N/A	0.2%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC											
2011	Winter	CO											
2011	Winter	NOX											
2011	Winter	PM2.5											
2022	Summer	THC	-1.6%	2.8%	-1.4%	9.4%	-1.9%	7.4%	0.0%	0.0%	0.0%	0.0%	0.8%
2022	Summer	CO	1.3%	#N/A	1.2%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.3%
2022	Summer	NOX	0.3%	#N/A	0.3%	#N/A	0.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC											
2022	Winter	CO											
2022	Winter	NOX											
2022	Winter	PM2.5											
2050	Summer	THC	-2.5%	2.0%	-2.4%	10.2%	-2.2%	8.2%	0.0%	0.0%	0.0%	0.0%	1.2%
2050	Summer	CO	1.4%	#N/A	1.2%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.4%
2050	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC											
2050	Winter	CO											
2050	Winter	NOX											
2050	Winter	PM2.5											

Table B-62
Wayne County (MI) Sensitivity Scenario 3 Emission Inventory, 100% E10 (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	17.633	10.032	1.194	0.499	0.697	0.684	0.208	2.980	0.125	0.781	34.832
2011	Summer	CO	306.504	0.000	28.951	0.000	10.076	0.000	3.681	13.699	0.208	1.253	364.374
2011	Summer	NOX	35.523	0.000	3.543	0.000	0.416	0.000	0.256	38.064	0.034	2.893	80.729
2011	Summer	PM2.5	0.333	0.000	0.028	0.000	0.016	0.000	0.004	1.674	0.435	0.056	2.546
2011	Winter	THC	31.111	4.276	1.150	0.234	0.600	0.364	0.243	2.652	0.110	0.660	41.401
2011	Winter	CO	358.801	0.000	28.138	0.000	9.679	0.000	2.639	11.457	0.172	1.065	411.951
2011	Winter	NOX	36.387	0.000	3.737	0.000	0.467	0.000	0.232	38.717	0.035	2.957	82.534
2011	Winter	PM2.5	1.316	0.000	0.100	0.000	0.026	0.000	0.003	1.419	0.369	0.047	3.280
2022	Summer	THC	5.097	4.605	0.299	0.301	0.439	0.644	0.046	0.793	0.014	0.649	12.888
2022	Summer	CO	162.941	0.000	11.576	0.000	7.002	0.000	1.438	3.509	0.019	1.211	187.696
2022	Summer	NOX	7.388	0.000	0.772	0.000	0.369	0.000	0.064	9.106	0.003	2.354	20.057
2022	Summer	PM2.5	0.230	0.000	0.019	0.000	0.015	0.000	0.002	0.223	0.086	0.014	0.590
2022	Winter	THC	10.828	2.174	0.307	0.149	0.356	0.357	0.116	0.820	0.013	0.550	15.667
2022	Winter	CO	163.691	0.000	10.258	0.000	6.343	0.000	0.941	2.994	0.016	1.026	185.268
2022	Winter	NOX	8.680	0.000	0.827	0.000	0.411	0.000	0.058	9.245	0.003	2.407	21.630
2022	Winter	PM2.5	0.465	0.000	0.031	0.000	0.014	0.000	0.002	0.189	0.073	0.012	0.786
2050	Summer	THC	1.216	2.497	0.127	0.252	0.411	0.604	0.014	0.538	0.001	0.729	6.388
2050	Summer	CO	56.728	0.000	4.664	0.000	6.712	0.000	0.606	2.499	0.001	1.386	72.596
2050	Summer	NOX	1.642	0.000	0.278	0.000	0.369	0.000	0.016	5.250	0.000	2.624	10.179
2050	Summer	PM2.5	0.128	0.000	0.018	0.000	0.016	0.000	0.001	0.075	0.046	0.013	0.296
2050	Winter	THC	6.458	1.459	0.152	0.133	0.315	0.351	0.100	0.618	0.001	0.617	10.204
2050	Winter	CO	77.802	0.000	4.499	0.000	5.862	0.000	0.396	2.159	0.000	1.174	91.893
2050	Winter	NOX	3.308	0.000	0.310	0.000	0.409	0.000	0.015	5.338	0.000	2.683	12.063
2050	Winter	PM2.5	0.187	0.000	0.017	0.000	0.012	0.000	0.001	0.063	0.039	0.011	0.329

Table B-63
Wayne County (MI) Sensitivity Scenario 3 Inventory Difference, 100% E10 Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.010	0.137	0.000	0.007	0.000	0.005	0.000	0.000	0.000	0.000	0.159
2011	Summer	CO	-2.883	0.000	-0.279	0.000	-0.038	0.000	0.000	0.000	0.000	0.000	-3.200
2011	Summer	NOX	0.248	0.000	0.024	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.275
2011	Summer	PM2.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
2011	Winter	THC	-0.121	0.025	-0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	-0.096
2011	Winter	CO	-2.866	0.000	-0.180	0.000	-0.037	0.000	0.000	0.000	0.000	0.000	-3.084
2011	Winter	NOX	0.235	0.000	0.024	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.262
2011	Winter	PM2.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
2022	Summer	THC	-0.010	0.013	-0.001	0.003	-0.001	0.005	0.000	0.000	0.000	0.000	0.010
2022	Summer	CO	0.869	0.000	0.064	0.000	0.042	0.000	0.000	0.000	0.000	0.000	0.974
2022	Summer	NOX	-0.027	0.000	-0.003	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	-0.032
2022	Summer	PM2.5	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001
2022	Winter	THC	-0.033	0.003	-0.001	0.001	-0.002	0.001	0.000	0.000	0.000	0.000	-0.031
2022	Winter	CO	0.884	0.000	0.081	0.000	0.048	0.000	0.000	0.000	0.000	0.000	1.013
2022	Winter	NOX	-0.027	0.000	-0.003	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	-0.033
2022	Winter	PM2.5	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001
2050	Summer	THC	-0.001	0.010	0.000	0.005	-0.001	0.010	0.000	0.000	0.000	0.000	0.023
2050	Summer	CO	0.560	0.000	0.043	0.000	0.075	0.000	0.000	0.000	0.000	0.000	0.679
2050	Summer	NOX	-0.009	0.000	-0.002	0.000	-0.003	0.000	0.000	0.000	0.000	0.000	-0.014
2050	Summer	PM2.5	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001
2050	Winter	THC	-0.018	0.002	-0.001	0.002	-0.003	0.002	0.000	0.000	0.000	0.000	-0.015
2050	Winter	CO	0.476	0.000	0.037	0.000	0.072	0.000	0.000	0.000	0.000	0.000	0.584
2050	Winter	NOX	-0.011	0.000	-0.002	0.000	-0.003	0.000	0.000	0.000	0.000	0.000	-0.016
2050	Winter	PM2.5	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.001

Table B-64
Wayne County (MI) Sensitivity Scenario 3, Percent Inventory Impact, 100% E10 Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.1%	1.4%	0.0%	1.4%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.5%
2011	Summer	CO	-0.9%	#N/A	-1.0%	#N/A	-0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.9%
2011	Summer	NOX	0.7%	#N/A	0.7%	#N/A	0.7%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Summer	PM2.5	0.4%	#N/A	0.3%	#N/A	0.8%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2011	Winter	THC	-0.4%	0.6%	-0.2%	1.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	-0.2%
2011	Winter	CO	-0.8%	#N/A	-0.6%	#N/A	-0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.7%
2011	Winter	NOX	0.6%	#N/A	0.6%	#N/A	0.6%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2011	Winter	PM2.5	0.1%	#N/A	0.1%	#N/A	0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	0.1%
2022	Summer	THC	-0.2%	0.3%	-0.2%	0.9%	-0.2%	0.8%	0.0%	0.0%	0.0%	0.0%	0.1%
2022	Summer	CO	0.5%	#N/A	0.6%	#N/A	0.6%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2022	Summer	NOX	-0.4%	#N/A	-0.4%	#N/A	-0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.2%
2022	Summer	PM2.5	-0.3%	#N/A	-0.4%	#N/A	-0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2022	Winter	THC	-0.3%	0.1%	-0.5%	0.8%	-0.5%	0.3%	0.0%	0.0%	0.0%	0.0%	-0.2%
2022	Winter	CO	0.5%	#N/A	0.8%	#N/A	0.8%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2022	Winter	NOX	-0.3%	#N/A	-0.4%	#N/A	-0.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.2%
2022	Winter	PM2.5	-0.2%	#N/A	-0.2%	#N/A	-0.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2050	Summer	THC	-0.1%	0.4%	-0.2%	1.9%	-0.2%	1.8%	0.0%	0.0%	0.0%	0.0%	0.4%
2050	Summer	CO	1.0%	#N/A	0.9%	#N/A	1.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.9%
2050	Summer	NOX	-0.5%	#N/A	-0.8%	#N/A	-0.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2050	Summer	PM2.5	-0.5%	#N/A	-0.8%	#N/A	-0.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.3%
2050	Winter	THC	-0.3%	0.1%	-0.5%	1.6%	-0.8%	0.7%	0.0%	0.0%	0.0%	0.0%	-0.2%
2050	Winter	CO	0.6%	#N/A	0.8%	#N/A	1.2%	#N/A	0.0%	0.0%	0.0%	0.0%	0.6%
2050	Winter	NOX	-0.3%	#N/A	-0.7%	#N/A	-0.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.1%
2050	Winter	PM2.5	-0.5%	#N/A	-0.6%	#N/A	-0.6%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.3%

Table B-65
Wayne County (MI) Sensitivity Scenario 4 Emission Inventory, 100% E15 (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	18.333	9.612	1.232	0.465	0.709	0.646	0.208	2.980	0.125	0.781	35.090
2011	Summer	CO	291.799	0.000	27.579	0.000	9.595	0.000	3.681	13.699	0.208	1.253	347.815
2011	Summer	NOX	36.718	0.000	3.664	0.000	0.431	0.000	0.256	38.064	0.034	2.893	82.060
2011	Summer	PM2.5	0.336	0.000	0.028	0.000	0.017	0.000	0.004	1.674	0.435	0.056	2.550
2011	Winter	THC	32.792	4.141	1.215	0.220	0.631	0.356	0.243	2.652	0.110	0.660	43.020
2011	Winter	CO	325.701	0.000	25.442	0.000	8.952	0.000	2.639	11.457	0.172	1.065	375.429
2011	Winter	NOX	37.647	0.000	3.867	0.000	0.483	0.000	0.232	38.717	0.035	2.957	83.939
2011	Winter	PM2.5	1.325	0.000	0.101	0.000	0.026	0.000	0.003	1.419	0.369	0.047	3.290
2022	Summer	THC	5.171	4.509	0.305	0.280	0.445	0.607	0.046	0.793	0.014	0.649	12.818
2022	Summer	CO	156.141	0.000	11.074	0.000	6.676	0.000	1.438	3.509	0.019	1.211	180.068
2022	Summer	NOX	7.600	0.000	0.798	0.000	0.382	0.000	0.064	9.106	0.003	2.354	20.308
2022	Summer	PM2.5	0.235	0.000	0.020	0.000	0.016	0.000	0.002	0.223	0.086	0.014	0.596
2022	Winter	THC	11.084	2.151	0.318	0.140	0.370	0.348	0.116	0.820	0.013	0.550	15.909
2022	Winter	CO	156.782	0.000	9.624	0.000	5.968	0.000	0.941	2.994	0.016	1.026	177.350
2022	Winter	NOX	8.895	0.000	0.853	0.000	0.424	0.000	0.058	9.245	0.003	2.407	21.885
2022	Winter	PM2.5	0.472	0.000	0.032	0.000	0.014	0.000	0.002	0.189	0.073	0.012	0.794
2050	Summer	THC	1.219	2.460	0.128	0.233	0.415	0.564	0.014	0.538	0.001	0.729	6.301
2050	Summer	CO	54.422	0.000	4.486	0.000	6.403	0.000	0.606	2.499	0.001	1.386	69.802
2050	Summer	NOX	1.678	0.000	0.287	0.000	0.382	0.000	0.016	5.250	0.000	2.624	10.237
2050	Summer	PM2.5	0.131	0.000	0.019	0.000	0.016	0.000	0.001	0.075	0.046	0.013	0.300
2050	Winter	THC	6.533	1.451	0.155	0.125	0.326	0.342	0.100	0.618	0.001	0.617	10.269
2050	Winter	CO	75.848	0.000	4.347	0.000	5.567	0.000	0.396	2.159	0.000	1.174	89.492
2050	Winter	NOX	3.351	0.000	0.318	0.000	0.421	0.000	0.015	5.338	0.000	2.683	12.127
2050	Winter	PM2.5	0.190	0.000	0.017	0.000	0.012	0.000	0.001	0.063	0.039	0.011	0.333

Table B-66
Wayne County (MI) Sensitivity Scenario 4 Inventory Difference, 100% E15 Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.709	-0.283	0.038	-0.027	0.012	-0.033	0.000	0.000	0.000	0.000	0.417
2011	Summer	CO	-17.588	0.000	-1.651	0.000	-0.520	0.000	0.000	0.000	0.000	0.000	-19.759
2011	Summer	NOX	1.443	0.000	0.146	0.000	0.017	0.000	0.000	0.000	0.000	0.000	1.606
2011	Summer	PM2.5	0.005	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.006
2011	Winter	THC	1.560	-0.111	0.063	-0.011	0.030	-0.008	0.000	0.000	0.000	0.000	1.523
2011	Winter	CO	-35.966	0.000	-2.876	0.000	-0.764	0.000	0.000	0.000	0.000	0.000	-39.607
2011	Winter	NOX	1.495	0.000	0.154	0.000	0.018	0.000	0.000	0.000	0.000	0.000	1.667
2011	Winter	PM2.5	0.011	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
2022	Summer	THC	0.064	-0.082	0.005	-0.018	0.005	-0.032	0.000	0.000	0.000	0.000	-0.059
2022	Summer	CO	-5.931	0.000	-0.438	0.000	-0.284	0.000	0.000	0.000	0.000	0.000	-6.653
2022	Summer	NOX	0.184	0.000	0.023	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.218
2022	Summer	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
2022	Winter	THC	0.224	-0.020	0.010	-0.008	0.013	-0.008	0.000	0.000	0.000	0.000	0.211
2022	Winter	CO	-6.025	0.000	-0.553	0.000	-0.327	0.000	0.000	0.000	0.000	0.000	-6.905
2022	Winter	NOX	0.187	0.000	0.023	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.222
2022	Winter	PM2.5	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
2050	Summer	THC	0.003	-0.027	0.001	-0.014	0.003	-0.029	0.000	0.000	0.000	0.000	-0.064
2050	Summer	CO	-1.746	0.000	-0.135	0.000	-0.234	0.000	0.000	0.000	0.000	0.000	-2.115
2050	Summer	NOX	0.027	0.000	0.007	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.044
2050	Summer	PM2.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2050	Winter	THC	0.057	-0.006	0.002	-0.006	0.008	-0.007	0.000	0.000	0.000	0.000	0.049
2050	Winter	CO	-1.479	0.000	-0.115	0.000	-0.223	0.000	0.000	0.000	0.000	0.000	-1.816
2050	Winter	NOX	0.033	0.000	0.007	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.049
2050	Winter	PM2.5	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003

Table B-67
Wayne County (MI) Sensitivity Scenario 4, Percent Inventory Impact, 100% E15 Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	4.0%	-2.9%	3.2%	-5.4%	1.8%	-4.8%	0.0%	0.0%	0.0%	0.0%	1.2%
2011	Summer	CO	-5.7%	#N/A	-5.6%	#N/A	-5.1%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.4%
2011	Summer	NOX	4.1%	#N/A	4.1%	#N/A	4.2%	#N/A	0.0%	0.0%	0.0%	0.0%	2.0%
2011	Summer	PM2.5	1.5%	#N/A	1.6%	#N/A	3.8%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2011	Winter	THC	5.0%	-2.6%	5.5%	-4.8%	5.0%	-2.2%	0.0%	0.0%	0.0%	0.0%	3.7%
2011	Winter	CO	-9.9%	#N/A	-10.2%	#N/A	-7.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-9.5%
2011	Winter	NOX	4.1%	#N/A	4.2%	#N/A	4.0%	#N/A	0.0%	0.0%	0.0%	0.0%	2.0%
2011	Winter	PM2.5	0.8%	#N/A	0.7%	#N/A	1.9%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2022	Summer	THC	1.3%	-1.8%	1.6%	-6.0%	1.1%	-5.1%	0.0%	0.0%	0.0%	0.0%	-0.5%
2022	Summer	CO	-3.7%	#N/A	-3.8%	#N/A	-4.1%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.6%
2022	Summer	NOX	2.5%	#N/A	2.9%	#N/A	3.0%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2022	Summer	PM2.5	1.8%	#N/A	2.4%	#N/A	3.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.8%
2022	Winter	THC	2.1%	-0.9%	3.3%	-5.2%	3.5%	-2.1%	0.0%	0.0%	0.0%	0.0%	1.3%
2022	Winter	CO	-3.7%	#N/A	-5.4%	#N/A	-5.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.7%
2022	Winter	NOX	2.1%	#N/A	2.8%	#N/A	2.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Winter	PM2.5	1.3%	#N/A	1.2%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	0.8%
2050	Summer	THC	0.2%	-1.1%	0.5%	-5.7%	0.7%	-4.9%	0.0%	0.0%	0.0%	0.0%	-1.0%
2050	Summer	CO	-3.1%	#N/A	-2.9%	#N/A	-3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.9%
2050	Summer	NOX	1.7%	#N/A	2.4%	#N/A	2.6%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2050	Summer	PM2.5	1.6%	#N/A	2.4%	#N/A	2.7%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2050	Winter	THC	0.9%	-0.4%	1.6%	-4.6%	2.6%	-2.0%	0.0%	0.0%	0.0%	0.0%	0.5%
2050	Winter	CO	-1.9%	#N/A	-2.6%	#N/A	-3.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.0%
2050	Winter	NOX	1.0%	#N/A	2.1%	#N/A	2.3%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2050	Winter	PM2.5	1.5%	#N/A	1.7%	#N/A	1.9%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%

Table B-68
Wayne County (MI) Sensitivity Scenario 4 Inventory Difference, 100% E15 Minus 100% E10 (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.700	-0.420	0.038	-0.034	0.012	-0.037	0.000	0.000	0.000	0.000	0.258
2011	Summer	CO	-14.705	0.000	-1.372	0.000	-0.482	0.000	0.000	0.000	0.000	0.000	-16.559
2011	Summer	NOX	1.195	0.000	0.121	0.000	0.015	0.000	0.000	0.000	0.000	0.000	1.331
2011	Summer	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
2011	Winter	THC	1.681	-0.136	0.065	-0.014	0.030	-0.009	0.000	0.000	0.000	0.000	1.619
2011	Winter	CO	-33.100	0.000	-2.696	0.000	-0.727	0.000	0.000	0.000	0.000	0.000	-36.523
2011	Winter	NOX	1.260	0.000	0.130	0.000	0.015	0.000	0.000	0.000	0.000	0.000	1.406
2011	Winter	PM2.5	0.009	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
2022	Summer	THC	0.074	-0.096	0.006	-0.021	0.006	-0.038	0.000	0.000	0.000	0.000	-0.069
2022	Summer	CO	-6.800	0.000	-0.502	0.000	-0.326	0.000	0.000	0.000	0.000	0.000	-7.628
2022	Summer	NOX	0.212	0.000	0.026	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.250
2022	Summer	PM2.5	0.005	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.006
2022	Winter	THC	0.256	-0.023	0.012	-0.009	0.015	-0.009	0.000	0.000	0.000	0.000	0.242
2022	Winter	CO	-6.909	0.000	-0.634	0.000	-0.375	0.000	0.000	0.000	0.000	0.000	-7.918
2022	Winter	NOX	0.215	0.000	0.027	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.254
2022	Winter	PM2.5	0.007	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007
2050	Summer	THC	0.004	-0.036	0.001	-0.019	0.004	-0.040	0.000	0.000	0.000	0.000	-0.087
2050	Summer	CO	-2.306	0.000	-0.178	0.000	-0.309	0.000	0.000	0.000	0.000	0.000	-2.794
2050	Summer	NOX	0.036	0.000	0.009	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.058
2050	Summer	PM2.5	0.003	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.004
2050	Winter	THC	0.075	-0.008	0.003	-0.008	0.011	-0.009	0.000	0.000	0.000	0.000	0.065
2050	Winter	CO	-1.954	0.000	-0.151	0.000	-0.294	0.000	0.000	0.000	0.000	0.000	-2.400
2050	Winter	NOX	0.043	0.000	0.009	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.064
2050	Winter	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004

Table B-69
Wayne County (MI) Sensitivity Scenario 4, Percent Inventory Impact, 100% E15 Relative to 100% E10 (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	4.0%	-4.2%	3.1%	-6.8%	1.8%	-5.5%	0.0%	0.0%	0.0%	0.0%	0.7%
2011	Summer	CO	-4.8%	#N/A	-4.7%	#N/A	-4.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.5%
2011	Summer	NOX	3.4%	#N/A	3.4%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.6%
2011	Summer	PM2.5	1.1%	#N/A	1.2%	#N/A	3.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2011	Winter	THC	5.4%	-3.2%	5.7%	-5.8%	5.1%	-2.4%	0.0%	0.0%	0.0%	0.0%	3.9%
2011	Winter	CO	-9.2%	#N/A	-9.6%	#N/A	-7.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.9%
2011	Winter	NOX	3.5%	#N/A	3.5%	#N/A	3.3%	#N/A	0.0%	0.0%	0.0%	0.0%	1.7%
2011	Winter	PM2.5	0.7%	#N/A	0.6%	#N/A	1.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2022	Summer	THC	1.4%	-2.1%	1.9%	-6.9%	1.3%	-5.8%	0.0%	0.0%	0.0%	0.0%	-0.5%
2022	Summer	CO	-4.2%	#N/A	-4.3%	#N/A	-4.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.1%
2022	Summer	NOX	2.9%	#N/A	3.4%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%
2022	Summer	PM2.5	2.0%	#N/A	2.8%	#N/A	3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Winter	THC	2.4%	-1.1%	3.8%	-5.9%	4.1%	-2.5%	0.0%	0.0%	0.0%	0.0%	1.5%
2022	Winter	CO	-4.2%	#N/A	-6.2%	#N/A	-5.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.3%
2022	Winter	NOX	2.5%	#N/A	3.2%	#N/A	3.2%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%
2022	Winter	PM2.5	1.5%	#N/A	1.4%	#N/A	2.0%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2050	Summer	THC	0.3%	-1.5%	0.7%	-7.5%	0.9%	-6.6%	0.0%	0.0%	0.0%	0.0%	-1.4%
2050	Summer	CO	-4.1%	#N/A	-3.8%	#N/A	-4.6%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.8%
2050	Summer	NOX	2.2%	#N/A	3.2%	#N/A	3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	0.6%
2050	Summer	PM2.5	2.2%	#N/A	3.2%	#N/A	3.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.3%
2050	Winter	THC	1.2%	-0.5%	2.1%	-6.1%	3.5%	-2.6%	0.0%	0.0%	0.0%	0.0%	0.6%
2050	Winter	CO	-2.5%	#N/A	-3.4%	#N/A	-5.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.6%
2050	Winter	NOX	1.3%	#N/A	2.8%	#N/A	3.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.5%
2050	Winter	PM2.5	2.0%	#N/A	2.3%	#N/A	2.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.3%

Table B-70
Wayne County (MI) Sensitivity Scenario 5 Emission Inventory, 100% E15 (T50 Update) (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	18.244	9.612	1.222	0.465	0.702	0.646	0.208	2.980	0.125	0.781	34.984
2011	Summer	CO	290.823	0.000	27.486	0.000	9.482	0.000	3.681	13.699	0.208	1.253	346.634
2011	Summer	NOX	36.794	0.000	3.670	0.000	0.432	0.000	0.256	38.064	0.034	2.893	82.143
2011	Summer	PM2.5	0.336	0.000	0.028	0.000	0.017	0.000	0.004	1.674	0.435	0.056	2.550
2011	Winter	THC	33.000	4.141	1.223	0.220	0.633	0.356	0.243	2.652	0.110	0.660	43.239
2011	Winter	CO	326.699	0.000	25.504	0.000	8.949	0.000	2.639	11.457	0.172	1.065	376.485
2011	Winter	NOX	37.684	0.000	3.871	0.000	0.483	0.000	0.232	38.717	0.035	2.957	83.980
2011	Winter	PM2.5	1.327	0.000	0.101	0.000	0.026	0.000	0.003	1.419	0.369	0.047	3.292
2022	Summer	THC	5.008	4.509	0.300	0.280	0.440	0.607	0.046	0.793	0.014	0.649	12.646
2022	Summer	CO	154.463	0.000	10.978	0.000	6.588	0.000	1.438	3.509	0.019	1.211	178.207
2022	Summer	NOX	7.561	0.000	0.798	0.000	0.382	0.000	0.064	9.106	0.003	2.354	20.269
2022	Summer	PM2.5	0.235	0.000	0.020	0.000	0.016	0.000	0.002	0.223	0.086	0.014	0.596
2022	Winter	THC	11.084	2.151	0.319	0.140	0.371	0.348	0.116	0.820	0.013	0.550	15.911
2022	Winter	CO	157.123	0.000	9.632	0.000	5.956	0.000	0.941	2.994	0.016	1.026	177.686
2022	Winter	NOX	8.879	0.000	0.853	0.000	0.424	0.000	0.058	9.245	0.003	2.407	21.869
2022	Winter	PM2.5	0.475	0.000	0.032	0.000	0.014	0.000	0.002	0.189	0.073	0.012	0.797
2050	Summer	THC	1.164	2.460	0.124	0.233	0.409	0.564	0.014	0.538	0.001	0.729	6.236
2050	Summer	CO	53.752	0.000	4.437	0.000	6.309	0.000	0.606	2.499	0.001	1.386	68.989
2050	Summer	NOX	1.657	0.000	0.286	0.000	0.382	0.000	0.016	5.250	0.000	2.624	10.215
2050	Summer	PM2.5	0.131	0.000	0.019	0.000	0.016	0.000	0.001	0.075	0.046	0.013	0.300
2050	Winter	THC	6.521	1.451	0.155	0.125	0.326	0.342	0.100	0.618	0.001	0.617	10.257
2050	Winter	CO	76.104	0.000	4.354	0.000	5.553	0.000	0.396	2.159	0.000	1.174	89.741
2050	Winter	NOX	3.338	0.000	0.318	0.000	0.421	0.000	0.015	5.338	0.000	2.683	12.113
2050	Winter	PM2.5	0.192	0.000	0.017	0.000	0.012	0.000	0.001	0.063	0.039	0.011	0.335

Table B-71
Wayne County (MI) Sensitivity Scenario 5 Inventory Difference, 100% E15 (T50 Update) Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.621	-0.283	0.028	-0.027	0.005	-0.033	0.000	0.000	0.000	0.000	0.311
2011	Summer	CO	-18.564	0.000	-1.744	0.000	-0.632	0.000	0.000	0.000	0.000	0.000	-20.940
2011	Summer	NOX	1.519	0.000	0.152	0.000	0.018	0.000	0.000	0.000	0.000	0.000	1.688
2011	Summer	PM2.5	0.005	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.006
2011	Winter	THC	1.768	-0.111	0.071	-0.011	0.033	-0.008	0.000	0.000	0.000	0.000	1.742
2011	Winter	CO	-34.968	0.000	-2.815	0.000	-0.767	0.000	0.000	0.000	0.000	0.000	-38.551
2011	Winter	NOX	1.532	0.000	0.158	0.000	0.019	0.000	0.000	0.000	0.000	0.000	1.708
2011	Winter	PM2.5	0.013	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
2022	Summer	THC	-0.099	-0.082	0.000	-0.018	0.000	-0.032	0.000	0.000	0.000	0.000	-0.231
2022	Summer	CO	-7.609	0.000	-0.534	0.000	-0.372	0.000	0.000	0.000	0.000	0.000	-8.515
2022	Summer	NOX	0.146	0.000	0.022	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.180
2022	Summer	PM2.5	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006
2022	Winter	THC	0.223	-0.020	0.011	-0.008	0.014	-0.008	0.000	0.000	0.000	0.000	0.213
2022	Winter	CO	-5.684	0.000	-0.545	0.000	-0.339	0.000	0.000	0.000	0.000	0.000	-6.569
2022	Winter	NOX	0.172	0.000	0.023	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.206
2022	Winter	PM2.5	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
2050	Summer	THC	-0.053	-0.027	-0.003	-0.014	-0.003	-0.029	0.000	0.000	0.000	0.000	-0.129
2050	Summer	CO	-2.416	0.000	-0.184	0.000	-0.328	0.000	0.000	0.000	0.000	0.000	-2.928
2050	Summer	NOX	0.007	0.000	0.006	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.022
2050	Summer	PM2.5	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2050	Winter	THC	0.045	-0.006	0.002	-0.006	0.009	-0.007	0.000	0.000	0.000	0.000	0.038
2050	Winter	CO	-1.222	0.000	-0.108	0.000	-0.237	0.000	0.000	0.000	0.000	0.000	-1.567
2050	Winter	NOX	0.019	0.000	0.006	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.035
2050	Winter	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005

Table B-72
Wayne County (MI) Sensitivity Scenario 5, Percent Inventory Impact, 100% E15 (T50 Update) Relative to Base Case (%)

Year	Season	Pollutant	Light-Duty Gasoline Exhaust	Light-Duty Gasoline Evap.	Heavy-Duty Gasoline Exhaust	Heavy-Duty Gasoline Evap.	Motorcycle Exhaust	Motorcycle Evap.	Light-Duty Diesel Exhaust	Heavy-Duty Diesel Exhaust	Heavy-Duty Diesel Crank Case	Heavy-Duty Diesel Idling / APU	Total On-Road
2011	Summer	THC	3.5%	-2.9%	2.4%	-5.4%	0.7%	-4.8%	0.0%	0.0%	0.0%	0.0%	0.9%
2011	Summer	CO	-6.0%	#N/A	-6.0%	#N/A	-6.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.7%
2011	Summer	NOX	4.3%	#N/A	4.3%	#N/A	4.3%	#N/A	0.0%	0.0%	0.0%	0.0%	2.1%
2011	Summer	PM2.5	1.5%	#N/A	1.6%	#N/A	3.8%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2011	Winter	THC	5.7%	-2.6%	6.2%	-4.8%	5.5%	-2.2%	0.0%	0.0%	0.0%	0.0%	4.2%
2011	Winter	CO	-9.7%	#N/A	-9.9%	#N/A	-7.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-9.3%
2011	Winter	NOX	4.2%	#N/A	4.2%	#N/A	4.0%	#N/A	0.0%	0.0%	0.0%	0.0%	2.1%
2011	Winter	PM2.5	1.0%	#N/A	0.8%	#N/A	1.9%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2022	Summer	THC	-1.9%	-1.8%	0.1%	-6.0%	0.0%	-5.1%	0.0%	0.0%	0.0%	0.0%	-1.8%
2022	Summer	CO	-4.7%	#N/A	-4.6%	#N/A	-5.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.6%
2022	Summer	NOX	2.0%	#N/A	2.9%	#N/A	3.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.9%
2022	Summer	PM2.5	2.0%	#N/A	2.5%	#N/A	3.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.9%
2022	Winter	THC	2.1%	-0.9%	3.5%	-5.2%	3.8%	-2.1%	0.0%	0.0%	0.0%	0.0%	1.4%
2022	Winter	CO	-3.5%	#N/A	-5.4%	#N/A	-5.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-3.6%
2022	Winter	NOX	2.0%	#N/A	2.8%	#N/A	2.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.0%
2022	Winter	PM2.5	1.9%	#N/A	1.4%	#N/A	1.8%	#N/A	0.0%	0.0%	0.0%	0.0%	1.2%
2050	Summer	THC	-4.4%	-1.1%	-2.3%	-5.7%	-0.8%	-4.9%	0.0%	0.0%	0.0%	0.0%	-2.0%
2050	Summer	CO	-4.3%	#N/A	-4.0%	#N/A	-4.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.1%
2050	Summer	NOX	0.4%	#N/A	2.2%	#N/A	2.6%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2050	Summer	PM2.5	1.9%	#N/A	2.5%	#N/A	2.7%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2050	Winter	THC	0.7%	-0.4%	1.6%	-4.6%	2.8%	-2.0%	0.0%	0.0%	0.0%	0.0%	0.4%
2050	Winter	CO	-1.6%	#N/A	-2.4%	#N/A	-4.1%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.7%
2050	Winter	NOX	0.6%	#N/A	2.0%	#N/A	2.3%	#N/A	0.0%	0.0%	0.0%	0.0%	0.3%
2050	Winter	PM2.5	2.4%	#N/A	2.1%	#N/A	1.9%	#N/A	0.0%	0.0%	0.0%	0.0%	1.5%

Table B-73
Wayne County (MI) Sensitivity Scenario 5 Inventory Difference, 100% E15 (T50 Update) Minus 100% E10 (Tons per Average Day)

Year	Season	Pollutant	Light-Duty Gasoline Exhaust	Light-Duty Gasoline Evap.	Heavy-Duty Gasoline Exhaust	Heavy-Duty Gasoline Evap.	Motorcycle Exhaust	Motorcycle Evap.	Light-Duty Diesel Exhaust	Heavy-Duty Diesel Exhaust	Heavy-Duty Diesel Crank Case	Heavy-Duty Diesel Idling / APU	Total On-Road
2011	Summer	THC	0.611	-0.420	0.028	-0.034	0.005	-0.037	0.000	0.000	0.000	0.000	0.152
2011	Summer	CO	-15.681	0.000	-1.465	0.000	-0.594	0.000	0.000	0.000	0.000	0.000	-17.740
2011	Summer	NOX	1.271	0.000	0.128	0.000	0.015	0.000	0.000	0.000	0.000	0.000	1.414
2011	Summer	PM2.5	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
2011	Winter	THC	1.889	-0.136	0.073	-0.014	0.033	-0.009	0.000	0.000	0.000	0.000	1.838
2011	Winter	CO	-32.102	0.000	-2.635	0.000	-0.730	0.000	0.000	0.000	0.000	0.000	-35.466
2011	Winter	NOX	1.297	0.000	0.133	0.000	0.016	0.000	0.000	0.000	0.000	0.000	1.446
2011	Winter	PM2.5	0.011	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.012
2022	Summer	THC	-0.089	-0.096	0.001	-0.021	0.001	-0.038	0.000	0.000	0.000	0.000	-0.242
2022	Summer	CO	-8.478	0.000	-0.598	0.000	-0.414	0.000	0.000	0.000	0.000	0.000	-9.490
2022	Summer	NOX	0.173	0.000	0.025	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.212
2022	Summer	PM2.5	0.005	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.006
2022	Winter	THC	0.256	-0.023	0.012	-0.009	0.015	-0.009	0.000	0.000	0.000	0.000	0.243
2022	Winter	CO	-6.569	0.000	-0.626	0.000	-0.387	0.000	0.000	0.000	0.000	0.000	-7.582
2022	Winter	NOX	0.199	0.000	0.027	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.239
2022	Winter	PM2.5	0.010	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.011
2050	Summer	THC	-0.052	-0.036	-0.003	-0.019	-0.002	-0.040	0.000	0.000	0.000	0.000	-0.152
2050	Summer	CO	-2.976	0.000	-0.228	0.000	-0.403	0.000	0.000	0.000	0.000	0.000	-3.607
2050	Summer	NOX	0.015	0.000	0.008	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.036
2050	Summer	PM2.5	0.003	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.004
2050	Winter	THC	0.063	-0.008	0.003	-0.008	0.011	-0.009	0.000	0.000	0.000	0.000	0.053
2050	Winter	CO	-1.698	0.000	-0.145	0.000	-0.308	0.000	0.000	0.000	0.000	0.000	-2.151
2050	Winter	NOX	0.030	0.000	0.008	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.051
2050	Winter	PM2.5	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006

Table B-74
Wayne County (MI) Sensitivity Scenario 5, Percent Inventory Impact, 100% E15 (T50 Update) Relative to 100% E10 (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	3.5%	-4.2%	2.3%	-6.8%	0.7%	-5.5%	0.0%	0.0%	0.0%	0.0%	0.4%
2011	Summer	CO	-5.1%	#N/A	-5.1%	#N/A	-5.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.9%
2011	Summer	NOX	3.6%	#N/A	3.6%	#N/A	3.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.8%
2011	Summer	PM2.5	1.1%	#N/A	1.2%	#N/A	3.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.2%
2011	Winter	THC	6.1%	-3.2%	6.4%	-5.8%	5.6%	-2.4%	0.0%	0.0%	0.0%	0.0%	4.4%
2011	Winter	CO	-8.9%	#N/A	-9.4%	#N/A	-7.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.6%
2011	Winter	NOX	3.6%	#N/A	3.6%	#N/A	3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	1.8%
2011	Winter	PM2.5	0.9%	#N/A	0.6%	#N/A	1.5%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2022	Summer	THC	-1.7%	-2.1%	0.3%	-6.9%	0.1%	-5.8%	0.0%	0.0%	0.0%	0.0%	-1.9%
2022	Summer	CO	-5.2%	#N/A	-5.2%	#N/A	-5.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.1%
2022	Summer	NOX	2.3%	#N/A	3.3%	#N/A	3.5%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2022	Summer	PM2.5	2.3%	#N/A	2.8%	#N/A	3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2022	Winter	THC	2.4%	-1.1%	4.0%	-5.9%	4.3%	-2.5%	0.0%	0.0%	0.0%	0.0%	1.6%
2022	Winter	CO	-4.0%	#N/A	-6.1%	#N/A	-6.1%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.1%
2022	Winter	NOX	2.3%	#N/A	3.2%	#N/A	3.2%	#N/A	0.0%	0.0%	0.0%	0.0%	1.1%
2022	Winter	PM2.5	2.1%	#N/A	1.6%	#N/A	2.0%	#N/A	0.0%	0.0%	0.0%	0.0%	1.4%
2050	Summer	THC	-4.3%	-1.5%	-2.1%	-7.5%	-0.6%	-6.6%	0.0%	0.0%	0.0%	0.0%	-2.4%
2050	Summer	CO	-5.2%	#N/A	-4.9%	#N/A	-6.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.0%
2050	Summer	NOX	0.9%	#N/A	3.0%	#N/A	3.4%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2050	Summer	PM2.5	2.4%	#N/A	3.3%	#N/A	3.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.4%
2050	Winter	THC	1.0%	-0.5%	2.1%	-6.1%	3.6%	-2.6%	0.0%	0.0%	0.0%	0.0%	0.5%
2050	Winter	CO	-2.2%	#N/A	-3.2%	#N/A	-5.3%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.3%
2050	Winter	NOX	0.9%	#N/A	2.7%	#N/A	3.1%	#N/A	0.0%	0.0%	0.0%	0.0%	0.4%
2050	Winter	PM2.5	2.9%	#N/A	2.7%	#N/A	2.6%	#N/A	0.0%	0.0%	0.0%	0.0%	1.8%

Table B-75
Wayne County (MI) Sensitivity Scenario 6 Emission Inventory, Add LD I/M (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	15.391	9.895	1.194	0.491	0.697	0.679	0.208	2.980	0.125	0.781	32.441
2011	Summer	CO	276.507	0.000	29.230	0.000	10.115	0.000	3.681	13.699	0.208	1.253	334.694
2011	Summer	NOX	31.382	0.000	3.518	0.000	0.414	0.000	0.256	38.064	0.034	2.893	76.562
2011	Summer	PM2.5	0.331	0.000	0.028	0.000	0.016	0.000	0.004	1.674	0.435	0.056	2.544
2011	Winter	THC	29.381	4.251	1.152	0.231	0.600	0.364	0.243	2.652	0.110	0.660	39.646
2011	Winter	CO	338.490	0.000	28.319	0.000	9.716	0.000	2.639	11.457	0.172	1.065	391.859
2011	Winter	NOX	32.439	0.000	3.713	0.000	0.464	0.000	0.232	38.717	0.035	2.957	78.559
2011	Winter	PM2.5	1.314	0.000	0.100	0.000	0.026	0.000	0.003	1.419	0.369	0.047	3.278
2022	Summer	THC	4.191	4.592	0.300	0.298	0.440	0.639	0.046	0.793	0.014	0.649	11.961
2022	Summer	CO	137.146	0.000	11.512	0.000	6.960	0.000	1.438	3.509	0.019	1.211	161.795
2022	Summer	NOX	6.457	0.000	0.775	0.000	0.371	0.000	0.064	9.106	0.003	2.354	19.131
2022	Summer	PM2.5	0.231	0.000	0.019	0.000	0.015	0.000	0.002	0.223	0.086	0.014	0.591
2022	Winter	THC	10.155	2.171	0.308	0.148	0.358	0.355	0.116	0.820	0.013	0.550	14.992
2022	Winter	CO	146.441	0.000	10.177	0.000	6.295	0.000	0.941	2.994	0.016	1.026	167.889
2022	Winter	NOX	7.813	0.000	0.830	0.000	0.412	0.000	0.058	9.245	0.003	2.407	20.768
2022	Winter	PM2.5	0.466	0.000	0.031	0.000	0.014	0.000	0.002	0.189	0.073	0.012	0.787
2050	Summer	THC	0.996	2.487	0.127	0.247	0.412	0.593	0.014	0.538	0.001	0.729	6.144
2050	Summer	CO	48.110	0.000	4.621	0.000	6.637	0.000	0.606	2.499	0.001	1.386	63.859
2050	Summer	NOX	1.434	0.000	0.280	0.000	0.372	0.000	0.016	5.250	0.000	2.624	9.977
2050	Summer	PM2.5	0.129	0.000	0.018	0.000	0.016	0.000	0.001	0.075	0.046	0.013	0.297
2050	Winter	THC	6.315	1.457	0.153	0.131	0.317	0.349	0.100	0.618	0.001	0.617	10.058
2050	Winter	CO	72.115	0.000	4.462	0.000	5.790	0.000	0.396	2.159	0.000	1.174	86.097
2050	Winter	NOX	3.120	0.000	0.312	0.000	0.412	0.000	0.015	5.338	0.000	2.683	11.880
2050	Winter	PM2.5	0.187	0.000	0.017	0.000	0.012	0.000	0.001	0.063	0.039	0.011	0.330

Table B-76
Wayne County (MI) Sensitivity Scenario 6 Inventory Difference, Add LD I/M Minus Base Case (Tons per Average Day)

Year	Season	Pollutant	Light-Duty Gasoline Exhaust	Light-Duty Gasoline Evap.	Heavy-Duty Gasoline Exhaust	Heavy-Duty Gasoline Evap.	Motorcycle Exhaust	Motorcycle Evap.	Light-Duty Diesel Exhaust	Heavy-Duty Diesel Exhaust	Heavy-Duty Diesel Crank Case	Heavy-Duty Diesel Idling / APU	Total On-Road
2011	Summer	THC	-2.232	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-2.232
2011	Summer	CO	-32.880	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-32.880
2011	Summer	NOX	-3.893	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-3.893
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC	-1.851	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-1.851
2011	Winter	CO	-23.177	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-23.177
2011	Winter	NOX	-3.713	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-3.713
2011	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	THC	-0.916	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.916
2022	Summer	CO	-24.926	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-24.926
2022	Summer	NOX	-0.958	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.958
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC	-0.706	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.706
2022	Winter	CO	-16.366	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-16.366
2022	Winter	NOX	-0.895	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.895
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	THC	-0.221	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.221
2050	Summer	CO	-8.058	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-8.058
2050	Summer	NOX	-0.216	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.216
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC	-0.162	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.162
2050	Winter	CO	-5.211	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-5.211
2050	Winter	NOX	-0.198	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.198
2050	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B-77
Wayne County (MI) Sensitivity Scenario 6, Percent Inventory Impact, Add LD I/M Relative to Base Case (%)

Year	Season	Pollutant	Light-Duty Gasoline Exhaust	Light-Duty Gasoline Evap.	Heavy-Duty Gasoline Exhaust	Heavy-Duty Gasoline Evap.	Motorcycle Exhaust	Motorcycle Evap.	Light-Duty Diesel Exhaust	Heavy-Duty Diesel Exhaust	Heavy-Duty Diesel Crank Case	Heavy-Duty Diesel Idling / APU	Total On-Road
2011	Summer	THC	-12.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-6.4%
2011	Summer	CO	-10.6%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.9%
2011	Summer	NOX	-11.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.8%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC	-5.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-4.5%
2011	Winter	CO	-6.4%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.6%
2011	Winter	NOX	-10.3%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.5%
2011	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	THC	-17.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-7.1%
2022	Summer	CO	-15.4%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-13.3%
2022	Summer	NOX	-12.9%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.8%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC	-6.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-4.5%
2022	Winter	CO	-10.1%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.9%
2022	Winter	NOX	-10.3%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-4.1%
2022	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	THC	-18.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-3.5%
2050	Summer	CO	-14.3%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-11.2%
2050	Summer	NOX	-13.1%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-2.1%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC	-2.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.6%
2050	Winter	CO	-6.7%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.7%
2050	Winter	NOX	-6.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.6%
2050	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%

Table B-78
Wayne County (MI) Scenario 7 Emission Inventory, Add SCR Start-Up (Tons per Average Day)

Year	Season	Pollutant	Light-Duty Gasoline Exhaust	Light-Duty Gasoline Evap.	Heavy-Duty Gasoline Exhaust	Heavy-Duty Gasoline Evap.	Motorcycle Exhaust	Motorcycle Evap.	Light-Duty Diesel Exhaust	Heavy-Duty Diesel Exhaust	Heavy-Duty Diesel Crank Case	Heavy-Duty Diesel Idling / APU	Total On-Road
2011	Summer	THC	17.624	9.895	1.194	0.491	0.697	0.679	0.208	2.980	0.125	0.781	34.673
2011	Summer	CO	309.387	0.000	29.230	0.000	10.115	0.000	3.681	13.699	0.208	1.253	367.574
2011	Summer	NOX	35.275	0.000	3.518	0.000	0.414	0.000	0.256	38.089	0.034	2.893	80.480
2011	Summer	PM2.5	0.331	0.000	0.028	0.000	0.016	0.000	0.004	1.674	0.435	0.056	2.544
2011	Winter	THC	31.232	4.251	1.152	0.231	0.600	0.364	0.243	2.652	0.110	0.660	41.497
2011	Winter	CO	361.667	0.000	28.319	0.000	9.716	0.000	2.639	11.457	0.172	1.065	415.036
2011	Winter	NOX	36.153	0.000	3.713	0.000	0.464	0.000	0.232	38.742	0.035	2.957	82.297
2011	Winter	PM2.5	1.314	0.000	0.100	0.000	0.026	0.000	0.003	1.419	0.369	0.047	3.278
2022	Summer	THC	5.107	4.592	0.300	0.298	0.440	0.639	0.046	0.793	0.014	0.649	12.877
2022	Summer	CO	162.072	0.000	11.512	0.000	6.960	0.000	1.438	3.509	0.019	1.211	186.722
2022	Summer	NOX	7.415	0.000	0.775	0.000	0.371	0.000	0.064	9.503	0.003	2.354	20.487
2022	Summer	PM2.5	0.231	0.000	0.019	0.000	0.015	0.000	0.002	0.223	0.086	0.014	0.591
2022	Winter	THC	10.861	2.171	0.308	0.148	0.358	0.355	0.116	0.820	0.013	0.550	15.698
2022	Winter	CO	162.807	0.000	10.177	0.000	6.295	0.000	0.941	2.994	0.016	1.026	184.255
2022	Winter	NOX	8.707	0.000	0.830	0.000	0.412	0.000	0.058	9.642	0.003	2.407	22.061
2022	Winter	PM2.5	0.466	0.000	0.031	0.000	0.014	0.000	0.002	0.189	0.073	0.012	0.787
2050	Summer	THC	1.217	2.487	0.127	0.247	0.412	0.593	0.014	0.538	0.001	0.729	6.365
2050	Summer	CO	56.168	0.000	4.621	0.000	6.637	0.000	0.606	2.499	0.001	1.386	71.917
2050	Summer	NOX	1.651	0.000	0.280	0.000	0.372	0.000	0.016	5.819	0.000	2.624	10.762
2050	Summer	PM2.5	0.129	0.000	0.018	0.000	0.016	0.000	0.001	0.075	0.046	0.013	0.297
2050	Winter	THC	6.476	1.457	0.153	0.131	0.317	0.349	0.100	0.618	0.001	0.617	10.220
2050	Winter	CO	77.326	0.000	4.462	0.000	5.790	0.000	0.396	2.159	0.000	1.174	91.308
2050	Winter	NOX	3.319	0.000	0.312	0.000	0.412	0.000	0.015	5.907	0.000	2.683	12.648
2050	Winter	PM2.5	0.187	0.000	0.017	0.000	0.012	0.000	0.001	0.063	0.039	0.011	0.330

Table B-79
Wayne County (MI) Scenario 7 Inventory Difference, Add SCR Start-Up Minus Base Case (Tons per Average Day)

Year	Season	Pollutant	Light-Duty Gasoline Exhaust	Light-Duty Gasoline Evap.	Heavy-Duty Gasoline Exhaust	Heavy-Duty Gasoline Evap.	Motorcycle Exhaust	Motorcycle Evap.	Light-Duty Diesel Exhaust	Heavy-Duty Diesel Exhaust	Heavy-Duty Diesel Crank Case	Heavy-Duty Diesel Idling / APU	Total On-Road
2011	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.025
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2011	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.000	0.025
2011	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.398	0.000	0.000	0.398
2022	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2022	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.398	0.000	0.000	0.398
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Summer	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.569	0.000	0.000	0.569
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	THC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	CO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2050	Winter	NOX	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.569	0.000	0.000	0.569
2050	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table B-80
Wayne County (MI) Scenario 7, Percent Inventory Impact, Add SCR Start-Up Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.1%	0.0%	0.0%	0.0%
2011	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2011	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.1%	0.0%	0.0%	0.0%
2011	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	4.4%	0.0%	0.0%	2.0%
2022	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	4.3%	0.0%	0.0%	1.8%
2022	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Summer	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	10.8%	0.0%	0.0%	5.6%
2050	Summer	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	THC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	CO	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2050	Winter	NOX	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	10.7%	0.0%	0.0%	4.7%
2050	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%

Table B-81
Wayne County (MI) Sensitivity Scenario 8 Emission Inventory, Federal RFG (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	16.075	9.583	1.105	0.461	0.663	0.646	0.208	2.980	0.125	0.781	32.627
2011	Summer	CO	287.940	0.000	27.310	0.000	9.031	0.000	3.681	13.699	0.208	1.253	343.123
2011	Summer	NOX	34.209	0.000	3.418	0.000	0.403	0.000	0.256	38.064	0.034	2.893	79.276
2011	Summer	PM2.5	0.296	0.000	0.026	0.000	0.014	0.000	0.004	1.674	0.435	0.056	2.504
2011	Winter	THC	30.283	4.104	1.124	0.217	0.597	0.354	0.243	2.652	0.110	0.660	40.344
2011	Winter	CO	337.603	0.000	26.219	0.000	9.031	0.000	2.639	11.457	0.172	1.065	388.187
2011	Winter	NOX	35.764	0.000	3.681	0.000	0.461	0.000	0.232	38.717	0.035	2.957	81.847
2011	Winter	PM2.5	1.272	0.000	0.098	0.000	0.025	0.000	0.003	1.419	0.369	0.047	3.233
2022	Summer	THC	4.810	4.491	0.286	0.274	0.428	0.602	0.046	0.793	0.014	0.649	12.393
2022	Summer	CO	152.623	0.000	10.905	0.000	6.268	0.000	1.438	3.509	0.019	1.211	175.972
2022	Summer	NOX	7.113	0.000	0.752	0.000	0.361	0.000	0.064	9.106	0.003	2.354	19.753
2022	Summer	PM2.5	0.188	0.000	0.016	0.000	0.013	0.000	0.002	0.223	0.086	0.014	0.542
2022	Winter	THC	10.914	2.137	0.307	0.136	0.358	0.345	0.116	0.820	0.013	0.550	15.695
2022	Winter	CO	163.500	0.000	9.881	0.000	5.970	0.000	0.941	2.994	0.016	1.026	184.327
2022	Winter	NOX	8.607	0.000	0.823	0.000	0.409	0.000	0.058	9.245	0.003	2.407	21.553
2022	Winter	PM2.5	0.420	0.000	0.030	0.000	0.013	0.000	0.002	0.189	0.073	0.012	0.739
2050	Summer	THC	1.152	2.452	0.122	0.228	0.402	0.560	0.014	0.538	0.001	0.729	6.199
2050	Summer	CO	52.832	0.000	4.491	0.000	5.957	0.000	0.606	2.499	0.001	1.386	67.772
2050	Summer	NOX	1.562	0.000	0.271	0.000	0.362	0.000	0.016	5.250	0.000	2.624	10.085
2050	Summer	PM2.5	0.102	0.000	0.015	0.000	0.013	0.000	0.001	0.075	0.046	0.013	0.265
2050	Winter	THC	6.566	1.444	0.154	0.120	0.319	0.338	0.100	0.618	0.001	0.617	10.279
2050	Winter	CO	79.932	0.000	4.499	0.000	5.521	0.000	0.396	2.159	0.000	1.174	93.683
2050	Winter	NOX	3.268	0.000	0.309	0.000	0.409	0.000	0.015	5.338	0.000	2.683	12.022
2050	Winter	PM2.5	0.163	0.000	0.015	0.000	0.011	0.000	0.001	0.063	0.039	0.011	0.302

Table B-82

Wayne County (MI) Sensitivity Scenario 8 Inventory Difference, Federal RFG Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-1.548	-0.312	-0.089	-0.030	-0.033	-0.033	0.000	0.000	0.000	0.000	-2.046
2011	Summer	CO	-21.447	0.000	-1.920	0.000	-1.084	0.000	0.000	0.000	0.000	0.000	-24.451
2011	Summer	NOX	-1.066	0.000	-0.101	0.000	-0.011	0.000	0.000	0.000	0.000	0.000	-1.178
2011	Summer	PM2.5	-0.035	0.000	-0.002	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	-0.040
2011	Winter	THC	-0.949	-0.148	-0.028	-0.015	-0.003	-0.010	0.000	0.000	0.000	0.000	-1.153
2011	Winter	CO	-24.064	0.000	-2.100	0.000	-0.685	0.000	0.000	0.000	0.000	0.000	-26.849
2011	Winter	NOX	-0.389	0.000	-0.033	0.000	-0.004	0.000	0.000	0.000	0.000	0.000	-0.425
2011	Winter	PM2.5	-0.042	0.000	-0.002	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.045
2022	Summer	THC	-0.297	-0.101	-0.014	-0.024	-0.012	-0.037	0.000	0.000	0.000	0.000	-0.484
2022	Summer	CO	-9.449	0.000	-0.607	0.000	-0.693	0.000	0.000	0.000	0.000	0.000	-10.749
2022	Summer	NOX	-0.302	0.000	-0.024	0.000	-0.010	0.000	0.000	0.000	0.000	0.000	-0.336
2022	Summer	PM2.5	-0.043	0.000	-0.003	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	-0.049
2022	Winter	THC	0.054	-0.033	-0.001	-0.012	0.000	-0.011	0.000	0.000	0.000	0.000	-0.003
2022	Winter	CO	0.693	0.000	-0.296	0.000	-0.325	0.000	0.000	0.000	0.000	0.000	0.072
2022	Winter	NOX	-0.100	0.000	-0.007	0.000	-0.003	0.000	0.000	0.000	0.000	0.000	-0.110
2022	Winter	PM2.5	-0.046	0.000	-0.002	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.048
2050	Summer	THC	-0.065	-0.035	-0.005	-0.019	-0.009	-0.034	0.000	0.000	0.000	0.000	-0.166
2050	Summer	CO	-3.335	0.000	-0.130	0.000	-0.680	0.000	0.000	0.000	0.000	0.000	-4.145
2050	Summer	NOX	-0.089	0.000	-0.009	0.000	-0.010	0.000	0.000	0.000	0.000	0.000	-0.108
2050	Summer	PM2.5	-0.026	0.000	-0.003	0.000	-0.003	0.000	0.000	0.000	0.000	0.000	-0.032
2050	Winter	THC	0.090	-0.013	0.002	-0.011	0.002	-0.011	0.000	0.000	0.000	0.000	0.059
2050	Winter	CO	2.606	0.000	0.038	0.000	-0.269	0.000	0.000	0.000	0.000	0.000	2.375
2050	Winter	NOX	-0.051	0.000	-0.003	0.000	-0.003	0.000	0.000	0.000	0.000	0.000	-0.056
2050	Winter	PM2.5	-0.025	0.000	-0.002	0.000	-0.001	0.000	0.000	0.000	0.000	0.000	-0.027

Table B-83

Wayne County (MI) Sensitivity Scenario 8, Percent Inventory Impact, Federal RFG Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	-8.8%	-3.2%	-7.4%	-6.2%	-4.8%	-4.9%	0.0%	0.0%	0.0%	0.0%	-5.9%
2011	Summer	CO	-6.9%	#N/A	-6.6%	#N/A	-10.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-6.7%
2011	Summer	NOX	-3.0%	#N/A	-2.9%	#N/A	-2.6%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.5%
2011	Summer	PM2.5	-10.7%	#N/A	-7.2%	#N/A	-14.5%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.6%
2011	Winter	THC	-3.0%	-3.5%	-2.4%	-6.4%	-0.6%	-2.7%	0.0%	0.0%	0.0%	0.0%	-2.8%
2011	Winter	CO	-6.7%	#N/A	-7.4%	#N/A	-7.1%	#N/A	0.0%	0.0%	0.0%	0.0%	-6.5%
2011	Winter	NOX	-1.1%	#N/A	-0.9%	#N/A	-0.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.5%
2011	Winter	PM2.5	-3.2%	#N/A	-1.9%	#N/A	-4.0%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.4%
2022	Summer	THC	-5.8%	-2.2%	-4.6%	-8.0%	-2.6%	-5.8%	0.0%	0.0%	0.0%	0.0%	-3.8%
2022	Summer	CO	-5.8%	#N/A	-5.3%	#N/A	-9.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.8%
2022	Summer	NOX	-4.1%	#N/A	-3.1%	#N/A	-2.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.7%
2022	Summer	PM2.5	-18.7%	#N/A	-15.2%	#N/A	-16.1%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.2%
2022	Winter	THC	0.5%	-1.5%	-0.3%	-8.0%	0.0%	-3.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	CO	0.4%	#N/A	-2.9%	#N/A	-5.2%	#N/A	0.0%	0.0%	0.0%	0.0%	0.0%
2022	Winter	NOX	-1.2%	#N/A	-0.8%	#N/A	-0.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.5%
2022	Winter	PM2.5	-9.8%	#N/A	-5.7%	#N/A	-5.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-6.1%
2050	Summer	THC	-5.3%	-1.4%	-3.6%	-7.6%	-2.3%	-5.7%	0.0%	0.0%	0.0%	0.0%	-2.6%
2050	Summer	CO	-5.9%	#N/A	-2.8%	#N/A	-10.2%	#N/A	0.0%	0.0%	0.0%	0.0%	-5.8%
2050	Summer	NOX	-5.4%	#N/A	-3.3%	#N/A	-2.8%	#N/A	0.0%	0.0%	0.0%	0.0%	-1.1%
2050	Summer	PM2.5	-20.5%	#N/A	-17.9%	#N/A	-16.9%	#N/A	0.0%	0.0%	0.0%	0.0%	-10.9%
2050	Winter	THC	1.4%	-0.9%	1.1%	-8.2%	0.7%	-3.2%	0.0%	0.0%	0.0%	0.0%	0.6%
2050	Winter	CO	3.4%	#N/A	0.8%	#N/A	-4.6%	#N/A	0.0%	0.0%	0.0%	0.0%	2.6%
2050	Winter	NOX	-1.5%	#N/A	-0.9%	#N/A	-0.7%	#N/A	0.0%	0.0%	0.0%	0.0%	-0.5%
2050	Winter	PM2.5	-13.3%	#N/A	-9.9%	#N/A	-7.4%	#N/A	0.0%	0.0%	0.0%	0.0%	-8.3%

Table B-84
Wayne County (MI) Sensitivity Scenario 9 Emission Inventory, National LDA/LDT Mix (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	17.684	9.903	1.194	0.491	0.697	0.679	0.209	2.980	0.040	0.906	34.783
2011	Summer	CO	310.392	0.000	29.230	0.000	10.115	0.000	3.714	13.699	0.067	1.461	368.678
2011	Summer	NOX	35.406	0.000	3.518	0.000	0.414	0.000	0.258	38.064	0.000	2.927	80.587
2011	Summer	PM2.5	0.332	0.000	0.028	0.000	0.016	0.000	0.004	1.674	0.171	0.491	2.716
2011	Winter	THC	31.279	4.255	1.152	0.231	0.600	0.364	0.245	2.652	0.038	0.770	41.587
2011	Winter	CO	362.326	0.000	28.319	0.000	9.716	0.000	2.664	11.457	0.058	1.238	415.777
2011	Winter	NOX	36.280	0.000	3.713	0.000	0.464	0.000	0.234	38.717	0.000	2.992	82.401
2011	Winter	PM2.5	1.315	0.000	0.100	0.000	0.026	0.000	0.003	1.419	0.152	0.416	3.430
2022	Summer	THC	5.111	4.584	0.300	0.298	0.440	0.639	0.047	0.793	0.006	0.663	12.880
2022	Summer	CO	162.467	0.000	11.512	0.000	6.960	0.000	1.453	3.509	0.010	1.229	187.140
2022	Summer	NOX	7.432	0.000	0.775	0.000	0.371	0.000	0.065	9.106	0.000	2.358	20.106
2022	Summer	PM2.5	0.231	0.000	0.019	0.000	0.015	0.000	0.002	0.223	0.036	0.100	0.628
2022	Winter	THC	10.861	2.168	0.308	0.148	0.358	0.355	0.117	0.820	0.006	0.562	15.702
2022	Winter	CO	163.010	0.000	10.177	0.000	6.295	0.000	0.950	2.994	0.009	1.041	184.476
2022	Winter	NOX	8.723	0.000	0.830	0.000	0.412	0.000	0.059	9.245	0.000	2.410	21.679
2022	Winter	PM2.5	0.467	0.000	0.031	0.000	0.014	0.000	0.002	0.189	0.033	0.085	0.820
2050	Summer	THC	1.217	2.485	0.127	0.247	0.412	0.593	0.014	0.538	0.000	0.730	6.364
2050	Summer	CO	56.242	0.000	4.621	0.000	6.637	0.000	0.614	2.499	0.000	1.386	71.998
2050	Summer	NOX	1.652	0.000	0.280	0.000	0.372	0.000	0.016	5.250	0.000	2.624	10.195
2050	Summer	PM2.5	0.129	0.000	0.018	0.000	0.016	0.000	0.001	0.075	0.014	0.058	0.312
2050	Winter	THC	6.478	1.455	0.153	0.131	0.317	0.349	0.101	0.618	0.000	0.619	10.221
2050	Winter	CO	77.375	0.000	4.462	0.000	5.790	0.000	0.401	2.159	0.000	1.174	91.362
2050	Winter	NOX	3.321	0.000	0.312	0.000	0.412	0.000	0.015	5.338	0.000	2.683	12.081
2050	Winter	PM2.5	0.188	0.000	0.017	0.000	0.012	0.000	0.001	0.063	0.008	0.049	0.339

Table B-85
Wayne County (MI) Sensitivity Scenario 9 Inventory Difference, National LDA/LDT Mix Minus Base Case (Tons per Average Day)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.061	0.007	0.000	0.000	0.000	0.000	0.002	0.000	-0.085	0.125	0.110
2011	Summer	CO	1.004	0.000	0.000	0.000	0.000	0.000	0.033	0.000	-0.142	0.208	1.104
2011	Summer	NOX	0.131	0.000	0.000	0.000	0.000	0.000	0.002	0.000	-0.034	0.034	0.132
2011	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.264	0.435	0.172
2011	Winter	THC	0.047	0.004	0.000	0.000	0.000	0.000	0.002	0.000	-0.072	0.110	0.091
2011	Winter	CO	0.659	0.000	0.000	0.000	0.000	0.000	0.024	0.000	-0.114	0.172	0.742
2011	Winter	NOX	0.127	0.000	0.000	0.000	0.000	0.000	0.002	0.000	-0.035	0.035	0.129
2011	Winter	PM2.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.217	0.369	0.153
2022	Summer	THC	0.005	-0.008	0.000	0.000	0.000	0.000	0.000	0.000	-0.008	0.014	0.003
2022	Summer	CO	0.394	0.000	0.000	0.000	0.000	0.000	0.015	0.000	-0.009	0.019	0.419
2022	Summer	NOX	0.016	0.000	0.000	0.000	0.000	0.000	0.001	0.000	-0.003	0.003	0.017
2022	Summer	PM2.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.050	0.086	0.037
2022	Winter	THC	0.000	-0.003	0.000	0.000	0.000	0.000	0.001	0.000	-0.007	0.013	0.004
2022	Winter	CO	0.203	0.000	0.000	0.000	0.000	0.000	0.010	0.000	-0.007	0.016	0.221
2022	Winter	NOX	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.003	0.003	0.016
2022	Winter	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.041	0.073	0.033
2050	Summer	THC	0.000	-0.002	0.000	0.000	0.000	0.000	0.000	0.000	-0.001	0.001	-0.002
2050	Summer	CO	0.074	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000	0.001	0.081
2050	Summer	NOX	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.002
2050	Summer	PM2.5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.031	0.046	0.015
2050	Winter	THC	0.001	-0.002	0.000	0.000	0.000	0.000	0.001	0.000	-0.001	0.001	0.002
2050	Winter	CO	0.049	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.054
2050	Winter	NOX	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
2050	Winter	PM2.5	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.030	0.039	0.009

Table B-86
Wayne County (MI) Sensitivity Scenario 9, Percent Inventory Impact, National LDA/LDT Mix Relative to Base Case (%)

			Light-Duty Gasoline		Heavy-Duty Gasoline		Motorcycle		Light-Duty Diesel	Heavy-Duty Diesel			
Year	Season	Pollutant	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Evap.	Exhaust	Exhaust	Crank Case	Idling / APU	Total On-Road
2011	Summer	THC	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	-68.0%	16.0%	0.3%
2011	Summer	CO	0.3%	#N/A	0.0%	#N/A	0.0%	#N/A	0.9%	0.0%	-68.0%	16.6%	0.3%
2011	Summer	NOX	0.4%	#N/A	0.0%	#N/A	0.0%	#N/A	0.6%	0.0%	-100.0%	1.2%	0.2%
2011	Summer	PM2.5	0.1%	#N/A	0.0%	#N/A	0.0%	#N/A	1.0%	0.0%	-60.6%	783.6%	6.8%
2011	Winter	THC	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.9%	0.0%	-65.7%	16.6%	0.2%
2011	Winter	CO	0.2%	#N/A	0.0%	#N/A	0.0%	#N/A	0.9%	0.0%	-66.2%	16.2%	0.2%
2011	Winter	NOX	0.4%	#N/A	0.0%	#N/A	0.0%	#N/A	0.7%	0.0%	-100.0%	1.2%	0.2%
2011	Winter	PM2.5	0.0%	#N/A	0.0%	#N/A	0.0%	#N/A	1.0%	0.0%	-58.8%	784.2%	4.7%
2022	Summer	THC	0.1%	-0.2%	0.0%	0.0%	0.0%	0.0%	1.0%	0.0%	-60.0%	2.2%	0.0%
2022	Summer	CO	0.2%	#N/A	0.0%	#N/A	0.0%	#N/A	1.0%	0.0%	-49.7%	1.6%	0.2%
2022	Summer	NOX	0.2%	#N/A	0.0%	#N/A	0.0%	#N/A	0.9%	0.0%	-100.0%	0.1%	0.1%
2022	Summer	PM2.5	0.3%	#N/A	0.0%	#N/A	0.0%	#N/A	1.0%	0.0%	-57.9%	615.4%	6.3%
2022	Winter	THC	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	1.1%	0.0%	-54.4%	2.3%	0.0%
2022	Winter	CO	0.1%	#N/A	0.0%	#N/A	0.0%	#N/A	1.0%	0.0%	-45.9%	1.5%	0.1%
2022	Winter	NOX	0.2%	#N/A	0.0%	#N/A	0.0%	#N/A	0.9%	0.0%	-100.0%	0.1%	0.1%
2022	Winter	PM2.5	0.1%	#N/A	0.0%	#N/A	0.0%	#N/A	1.0%	0.0%	-55.4%	615.7%	4.2%
2050	Summer	THC	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%	-70.0%	0.2%	0.0%
2050	Summer	CO	0.1%	#N/A	0.0%	#N/A	0.0%	#N/A	1.2%	0.0%	-69.1%	0.0%	0.1%
2050	Summer	NOX	0.1%	#N/A	0.0%	#N/A	0.0%	#N/A	1.2%	0.0%	-100.0%	0.0%	0.0%
2050	Summer	PM2.5	0.3%	#N/A	0.0%	#N/A	0.0%	#N/A	1.1%	0.0%	-68.8%	365.3%	4.9%
2050	Winter	THC	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	1.3%	0.0%	-70.8%	0.2%	0.0%
2050	Winter	CO	0.1%	#N/A	0.0%	#N/A	0.0%	#N/A	1.2%	0.0%	-72.3%	0.0%	0.1%
2050	Winter	NOX	0.1%	#N/A	0.0%	#N/A	0.0%	#N/A	1.2%	0.0%	-100.0%	0.0%	0.0%
2050	Winter	PM2.5	0.3%	#N/A	0.0%	#N/A	0.0%	#N/A	1.1%	0.0%	-78.3%	365.4%	2.7%

Appendix C

Critical Evaluation Findings and the Release of MOVES2014a

Appendix C

Critical Evaluation Findings and the Release of MOVES2014a

During the course of executing this project, the U.S. Environmental Protection Agency (EPA) released MOVES2014a in November 2015. A number of the findings from the critical evaluation of MOVES2014 were subsequently addressed by the agency in MOVES2014a. This appendix discusses the key differences between MOVES2014 and MOVES2014a specifically as related to the evaluation elements summarized in Section 3 of this report.

Notably, MOVES2014a is a minor revision of MOVES2014. The term "minor" revision in this case means that for official planning purposes, the two models are interchangeable and the use of MOVES2014a does not disrupt the planning activities already underway by users of MOVES2014. Thus, a high degree of continuity between MOVES2014 and MOVES2014a is expected.

The ten technical elements of the MOVES2014 evaluation discussed in Section 3 are listed below. Each of these was reviewed for changes in data or methods in the MOVES2014a release.

1. Heavy-Duty Diesel Emission Rates
2. Light-Duty Gasoline Exhaust Rates
3. Light-Duty Gasoline Evaporative Rates
4. Gasoline Parameter Modeling on Exhaust
5. Fuel Formulation Data & Fuel Wizard
6. Activity Data
7. Temperature Corrections
8. Chemical Speciation
9. I/M Programs
10. Operating Mode Functionality

Model updates reflected in MOVES2014a had implications for three of the above ten technical elements (fuel formulation data & fuel wizard, activity data, and chemical speciation). For completeness, the implications of the MOVES2014a release for each of the ten technical elements of the critical evaluation are discussed herein.

C.1 Heavy-Duty Diesel Emission Rates

The evaluation of heavy-duty Diesel emission rates covered the following topics:

- SCR NOx control effectiveness;
- NOx start exhaust from SCR-equipped vehicles;
- Phase-in of 0.2 g/bhp-hr NOx;
- Pre-2007 model year crankcase emissions;
- Greenhouse gas (GHG) rule impacts; and
- Hole-filling procedures and additional data sources.

We did not find any differences between MOVES2014 and MOVES2014a concerning the methods/data for heavy-duty Diesel emission rates that impacted the discussions and recommendations in Section 3 of this report. As such, the following four recommendations remain applicable to MOVES2014a: (1) incorporate NOx start exhaust rates for SCR-equipped vehicles, (2) improve the modeling of SCR control effectiveness by operating mode, (3) revise the method for crankcase PM emissions from pre-2007 model year vehicles, and (4) fully integrate the delay in the 0.2 gram NOx standard throughout the methodology.

C.2 Light-Duty Gasoline Exhaust Rates

The evaluation of light-duty gasoline exhaust rates covered the following topics:

- Hole-filling procedures and future updates to the emission rate data;
- Exhaust PM emission rates for GDI engines;
- Tier 3 emission rate review; and
- Emission rate validation and operating mode distributions.

We did not find any differences between MOVES2014 and MOVES2014a concerning the methods/data for light-duty gasoline exhaust emission rates that impacted the discussions and recommendations in Section 3 of this report. As such, the single recommendation of updating the PM exhaust emission rates for GDI engine technology remains applicable to MOVES2014a.

C.3 Light-Duty Gasoline Evaporative Rates

The evaluation of light-duty gasoline evaporative rates covered the following topics:

- Modal evaporative emissions processes;
- Federal regulatory standards phase-in;
- California emission standards;
- Permeation rates for near-zero and zero evaporative standards; and
- Tier 3 emission rate review.

We did not find any differences between MOVES2014 and MOVES2014a concerning the methods/data for light-duty gasoline evaporative emission rates that impacted the discussions and recommendations in Section 3 of this report. As such, the following three recommendations remain applicable to MOVES2014a: (1) update the permeation rates for near zero (Tier 2) evaporative standards; (2) update the federal regulatory implementation schedule of evaporative standards (enhanced and Tier 2 evaporative standards) with sales-based estimates, and (3) evaluate the potential presence of zero evaporative standard vehicles in the federal certification region.

C.4 Gasoline Parameter Modeling on Exhaust

The evaluation of gasoline parameter modeling on exhaust covered the following topics:

- Non-sulfur fuel corrections (2001 and newer model years);
- Non-sulfur fuel corrections (2000 and older model years);
- E15 modeling issues;
- RVP modeling issues; and
- Tier 2 vehicle sulfur corrections.

We did not find any differences between MOVES2014 and MOVES2014a concerning the methods/data for modeling gasoline parameter impacts on exhaust that influenced the discussions and recommendations in Section 3 of this report. As such, the following three recommendations remain applicable to MOVES2014a: (1) update the modeling method to restrict E15 use to the subset of vehicles approved for the higher ethanol blend, (2) develop the method to estimate winter-season RVP impacts on exhaust emissions from gasoline, and (3) update the non-sulfur fuel corrections for 2001 and newer model years to incorporate the data from the follow-up CRC E-98 project.

C.5 Fuel Formulation Data & Fuel Wizard

The evaluation of fuel formulation data and fuel wizard covered the following topics:

- Regional fuel modeling;
- Fuel Wizard and standardized relationships for ethanol, RVP, and sulfur;
- Sensitivity cases defined from the standardized relationships;
- County fuel assignments;
- Fuel formulation data review; and
- MTBE-containing gasoline.

There were significant updates in the MOVES2014a data and methods related to two of the topics above: the fuel wizard and the fuel formulation data review. Those MOVES2014a updates and their implications are described in detail below. For the remaining topics, we did not find any differences in the methods/data between

MOVES2014 and MOVES2014a, and the following nine recommendations remain applicable to MOVES2014a:

1. Create a historically complete county-to-fuel-region assignment (the default is static, i.e., identical for all calendar years);
2. Increase the number of fuel regions from 22 to 24 in order to distinguish all possible combinations of underlying regulatory context;
3. Develop a method to allow for evaluating the MTBE oxygenate additive;
4. Develop guidance or a modeling tool to assist state and local agencies in regularly incorporating EIA's Annual Energy Outlook into market share forecasts of the various ethanol blends;
5. Incorporate data-derived sulfur content of conventional gasoline for the period from 2011 through 2016;
6. Remove the unused fields of "volToWtPercentOxy," "CetaneIndex," and "PAHContent" from the fuel formulation data table as their presence is misleading;
7. Check the correctness of the summer RVP assumption for Fuel Region ID = 100010000;
8. Check the correctness of suspect T90 values present in 55 fuel formulations; and
9. Review the reformulated gasoline assignments to keep counties of the same VOC control region together.

C.5.1 Fuel Wizard

The MOVES2014a version of the fuel wizard corrected the computational errors noted in the MOVES2014 review. The rigorousness of the fuel wizard was tested for changes in RVP and ethanol content and found to produce the results intended in the documentation. Table C-1 presents the fuel parameter changes observed from applying the fuel wizard for selected changes to ethanol and RVP. These changes are consistent with those reported in Table 3-13 of the main report.

Table C-1 Confirmed Parameter Relationships Changes by MOVES2014a Fuel Wizard					
	Incremental Parameter Adjustment (Additive)				
	Ethanol (0 to 10 vol%)		Ethanol (10 to 15 vol%)		RVP (1 psi decrease)
Parameter	**Winter**	**Summer**	**Winter**	**Summer**	**All Seasons**
Ethanol Factor (%)	10	10	5	5	0
Sulfur Factor (ppm)	0	0	0	0	0
RVP Factor (psi)	1	1	0	0	-1
Aromatics Factor (%)	-3.65	-2.02	-2.04	-1.34	0
Olefin Factor (%)	-2.07	-0.46	-1.2	-1.18	0
Benzene Factor (%)	0	0	0	0	0
E200 Factor (%)	4.88	3.11	6.23	6.13	-1.26
E300 Factor (%)	0.54	0.39	0.47	0.52	-0.5
T50 Factor (°F)	-9.96	-6.34	-12.71	-12.52	2.57
T90 Factor (°F)	-2.45	-1.77	-2.14	-2.37	2.27

C.5.2 Fuel Formulation Data Review and Fuel Supply Defaults

The MOVES2014a fuel formulation data and associated fuel supply defaults, which define the sales share of marketed ethanol blends, were reviewed and found to be consistent with the most recent version of EIA's *Annual Energy Outlook 2015* (AEO2015). These data differed from those used to develop MOVES2014 defaults (based on AEO2013). Notably, the most significant change observed was that the near-term (approximately over the next five years) E15 market share is less in MOVES2014a.

Table C-2 summarizes the calendar year 2022 E15 market share assumptions contained within the default databases of both model versions for the three study locations of the inventory analysis. Note that the value of zero percent for Maricopa County is an error (as discussed in Section 3), and that error has been corrected in MOVES2014a.

Table C-2 Summary of Default E15 Market Share in Calendar Year 2022 Gasoline by Model Version		
Location	**MOVES2014**	**MOVES2014a**
Fulton County, GA	12%	8%
Maricopa County, AZ	100%*	0%
Wayne County, MI	13%	8%

C.6 Activity Data

The evaluation of the activity data covered the following topics:

- New trip activity inputs;
- Relative mileage accumulation rates and VMT distribution;
- EPA age distribution tool; and
- Use of VIUS data.

There was a significant update to the MOVES2014a approach to the relative mileage accumulation rates and VMT distributions; that update is described in detail below. For the remaining activity topics, we did not find any differences between MOVES2014 and MOVES2014a concerning the methods/data. The single recommendation that the USEPA develop guidance on recommendations and suggestions for preparing vehicle trip activity inputs in combination with vehicle soak distributions remains applicable to MOVES2014a.

C.6.1 Relative Mileage Accumulation Rates and VMT Distribution

MOVES2014a added a significant new feature that allows for the option to input VMT data by individual source type; this augments the preexisting method of inputting VMT by HPMS type. These vehicle class schemes—source type and HPMS type—are summarized in Table C-3. Previously in MOVES2010 and MOVES2014, VMT could be entered only by HPMS type.

This new feature substantially changes the nature of the discussion topic "relative mileage accumulation rates and VMT distribution" in Section 3 of this report. Notably, MOVES2014a did not change the definition of the relative mileage accumulation rate (or relative MAR) or the underlying default values. But the new input option circumvents the VMT distribution calculations of the model (by allowing direct input of VMT by source type), and the relative MAR is the modeling variable implicit in that distribution function.

* The Maricopa County default in MOVES2014 (which represents a fuel region that includes AZ and CA reformulated gasoline) was confirmed to be the result of a processing error by EPA. We assumed a value of 0 percent in the inventory analysis conducted for this project, as described in Section 4.

Table C-3
"Source Type" and "HPMS Type" Vehicle Classification Schemes

Source Type	HPMS Type
Motorcycles	Motorcycles
Passenger Cars	Light-Duty Vehicles
Passenger Trucks	
Light Commercial Trucks	
Intercity Buses	Buses
Transit Buses	
School Buses	
Refuse Trucks	Single Unit Trucks
Single Unit Short-Haul Trucks	
Single Unit Long-Haul Trucks	
Motor Homes	
Combination Short-Haul Trucks	Combination Trucks

Our recommendation, described in Section 3, was to redefine the relative MAR such that mileage accumulation rates were input into the model in absolute terms (i.e., miles per year by source type by age). This finding was based on a presumption that model users would better understand the parameter. This new VMT input feature lessens the need for such a change to the definition of mileage accumulation rates because those data have a reduced role in the model calculations.[*]

C.7 Temperature Corrections

The evaluation of the temperature corrections covered the following topics:

- Temperature corrections for PM running exhaust; and
- Temperature corrections for heavy-duty diesel THC exhaust.

We did not find any differences between MOVES2014 and MOVES2014a concerning the methods/data for temperature corrections that influenced the discussions in Section 3 of this report. There were no recommendations resulting from the MOVES2014 review, and none is suggested for MOVES2014a.

C.8 Chemical Speciation

The evaluation of the chemical speciation covered the following topics:

[*] The relative MAR still serves to apportion VMT by age in MOVES2014a within a given source type.

- SMOKE versus MOVES application of air quality model speciation;
- Diesel crankcase speciation; and
- E85 speciation.

The method for speciation of E85 was significantly updated in MOVES2014a; that update is described below. For the remaining topics, we did not find any differences between MOVES2014 and MOVES2014a concerning the methods/data. A single recommendation that the USEPA implement separate speciation profiles for start and running exhaust remains applicable to MOVES2014a.

C.8.1 E85 Speciation

There was a modeling issue noted in the MOVES2014 review—presumed to be related to speciation input parameters—such that MOVES2014 did not produce evaporative VOC emissions from flexible-fueled vehicles (i.e., FFVs) when operating on E85 fuel.* Our examination of MOVES2014a found that this issue had been fully addressed. MOVES2014a does estimate VOC evaporative emissions and speciated VOC evaporative emissions from FFVs operating on E85.

As a side note, it was also noted that exhaust emissions from FFVs operating on E85 did not yield any exhaust emissions of 1,3-butadiene. That observation was communicated to EPA and found to be in line with the supporting test data, which showed that 1,3-butadiene exhaust is below detection limits for vehicle using E85. As such (in both MOVES2014 and MOVES2014a), 1,3-butadiene exhaust emission estimates are zero from a vehicle operating on E85.

C.9 I/M Programs

The evaluation of vehicle I/M programs covered the following two topics:

- Fundamental I/M approach; and
- I/M Impacts on start exhaust.

We did not find any differences between MOVES2014 and MOVES2014a concerning the methods/data for I/M programs that influenced the discussions and recommendations in Section 3 of this report. As such the following two recommendations remain applicable to MOVES2014a: 1) to develop a start exhaust benefit based on an I/M program evaluation and 2) to review the interaction between I/M adjustment factors for correctness as they are applied in both the determination of emission rates for I/M and non-I/M areas.

* This issue is specific to the operation on E85. For FFVs operating on gasoline, MOVES2014 does perform correctly.

C.10 Operating Mode Functionality

The evaluation of operating mode functionality contained in Section 3 of this document recommends (a) allowance for direct input of operating modes in all inventory scales and (b) improved reporting of operating modes in the model output. There were no changes to this recommendation based on our review of MOVES2014a.