# Summary

## S.1 FOREWORD

The National Highway Traffic Safety Administration (NHTSA) prepared this Final Environmental Impact Statement (FEIS) to analyze and disclose the potential environmental impacts of Corporate Average Fuel Economy (CAFE) standards for the total fleet of passenger and non-passenger automobiles (later referred to as cars and light trucks, respectively) and reasonable alternative standards for the NHTSA CAFE Program pursuant to Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) implementing regulations, U.S. Department of Transportation (DOT) Order 5610.1C, and NHTSA regulations.[1] This FEIS compares the potential environmental impacts of alternative mpg levels that will be considered by NHTSA for the final rule, including the Preferred Alternative and a No Action Alternative. It also analyzes direct, indirect, and cumulative impacts and analyzes impacts in proportion to their significance. A broad and comprehensive analysis of the alternatives, varied by economic inputs and sensitivities, and likely environmental impacts are included in this FEIS for decisionmakers.

## S.2 BACKGROUND

The Energy Policy and Conservation Act of 1975 established a program to regulate automobile fuel economy and provided for the establishment of average fuel economy standards for passenger cars and separate standards for light trucks. As part of that Act, the CAFE Program was established to reduce national energy consumption by increasing the fuel economy of cars and light trucks. The Act directs the Secretary of Transportation to set and implement fuel economy standards for cars and light trucks sold in the United States. NHTSA is delegated responsibility for implementing the Energy Policy and Conservation Act fuel economy requirements assigned to the Secretary of Transportation.

In December 2007, the Energy Independence and Security Act of 2007 amended Energy Policy and Conservation Act CAFE Program requirements and granted DOT additional rulemaking authority. Pursuant to the Energy Independence and Security Act, on April 22, 2008, NHTSA proposed CAFE standards for model year (MY) 2011-2015 passenger cars and light trucks in a Notice of Proposed Rulemaking issued on May 2, 2008.

## S.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

The Energy Independence and Security Act sets forth extensive requirements for the rulemaking, and those requirements form the purpose of and need for the standards. The requirements also were the basis for establishing the range of alternatives considered in this FEIS. Specifically, the Energy Policy and Conservation Act requires the Secretary of Transportation to establish average fuel economy standards for each model year at least 18 months before the beginning of that model year and to set them at "the maximum feasible average fuel economy level that the Secretary decides the manufacturers can achieve in that model year." When setting maximum feasible fuel economy standards, the Secretary is required to "consider technological feasibility, economic practicability, the effect of other motor vehicle standards of the Government on fuel economy, and the need of the United States to conserve energy." NHTSA interprets the statutory factors as including environmental issues and permitting the consideration of other relevant societal issues, such as safety. The purpose of this FEIS is to disclose and

[1] NEPA is codified at 42 U.S.C. § 4321-4347. CEQ NEPA implementing regulations are codified at 40 Code of Federal Regulations (CFR) Parts 1500-1508. NHTSA NEPA implementing regulations are codified at 49 CFR Part 520.

analyze the potential environmental impacts of the standards and alternatives for consideration by the NHTSA decisionmaker.

The Energy Independence and Security Act further directs the Secretary, after consultation with the Secretary of Energy and the Administrator of the U.S. Environmental Protection Agency (EPA), to establish separate average fuel economy standards for passenger cars and for light trucks manufactured in each model year beginning with MY 2011 "to achieve a combined fuel economy average for MY 2020 of at least 35 miles per gallon for the total fleet of passenger and non-passenger automobiles manufactured for sale in the United States for that model year." In this FEIS, passenger and non-passenger are also referred to as the car and light truck fleet. In so doing, the Secretary of Transportation is to adopt "annual fuel economy standard increases," but in any single rulemaking, standards may be established for not more than 5 model years. This FEIS covers the initial 5-year rulemaking and also considers the cumulative impacts of reaching the 35-miles-per-gallon (mpg) total fleet requirement during the second 5-year period, MY 2016-2020.

## S.4 ALTERNATIVES

NEPA requires an agency to compare the potential environmental impacts of its proposed action and a reasonable range of alternatives. The Energy Policy and Conservation Act fuel economy requirements, including the four factors NHTSA must consider in determining maximum feasible CAFE levels – technological feasibility, economic practicability, the need to conserve energy, and the effect of other standards of the Government on fuel economy – form the purpose of and need for the MY 2011-2015 CAFE standards and, therefore, inform the range of alternatives for consideration in this NEPA analysis. NHTSA recognizes that several alternative CAFE levels are conceivable and that the alternatives represent several points on a continuum of alternatives. The NHTSA decision process must balance the four Energy Policy and Conservation Act factors and be informed by the environmental considerations of NEPA. In developing its reasonable range of alternatives, NHTSA identified alternative stringencies that represent the full spectrum of potential environmental impacts and safety considerations. The Draft Environmental Impact Statement (DEIS) and this FEIS analyze the impacts of six "action" alternatives and the impacts that would be expected if NHTSA imposed no new requirements (the No Action Alternative).

In response to public comments on the DEIS, this FEIS also examines how these alternatives are affected by variations in the economic assumptions input to the computer model NHTSA uses to calculate the costs and benefits of various CAFE standards (the Volpe model). NHTSA calculated and analyzed mpg standards and environmental impacts associated with each alternative under several model input scenarios. The "Reference Case" uses as model inputs the Energy Information Administration's reference case fuel price forecast and a domestic social cost of carbon. The "High Scenario" uses as model inputs the Energy Information Administration's high case for fuel price forecast and a global social cost of carbon. Values for the domestic and social costs of carbon have been updated from the DEIS, as have those for the costs of oil externalities. NHTSA also examined two other input scenarios, Mid-1 and Mid-2 Scenarios, to show how input values between those used in the Reference Case and the High Scenario result in mpg that falls between the mpg associated with the Reference Case and the High Scenario. All input scenarios use a 3-percent discount rate to calculate the current value of carbon emissions reductions. The High Scenario also uses a 3-percent discount rate to calculate the current value of other costs and benefits, while the Reference Case and Mid-1 and Mid-2 Scenarios use a 7-percent discount rate to calculate the current value of costs and benefits other than future carbon reductions.

NHTSA's Preferred Alternative is the Optimized Alternative (Alternative 3), which establishes optimized mpg standards that yield the greatest net benefits of all feasible alternatives. As mpg standards

are increased beyond this optimized level, manufacturers would be forced to apply technologies that entail higher incremental costs than benefits, thereby reducing total net benefits.

The most stringent alternative NHTSA analyzed is the Technology Exhaustion Alternative (Alternative 7), which represents the level at which vehicle manufacturers apply all feasible technologies, while recognizing that some must still be installed as part of a vehicle freshening or redesign. Alternative 7 would yield negative net benefits. Another specific alternative NHTSA analyzed was the Total Costs Equal Total Benefits Alternative (Alternative 6), the second most stringent alternative, under which manufacturers would be forced to apply technologies until total costs equal total benefits, yielding zero net benefits. Three other alternatives NHTSA analyzed (Alternatives 2, 4, and 5) illustrate how costs, benefits, and net benefits vary across other possible CAFE standards between the No Action Alternative (Alternative 1) and the Total Costs Equal Total Benefits Alternative (Alternative 6).

As shown in Table S-1, the 50 Percent Above Optimized Alternative would generate a 2015 mpg standard half way between the Optimized and Total Costs Equal Total Benefits Alternatives. The 25 Percent Above Optimized Alternative would generate a 2015 mpg standard halfway between the Optimized and 50 Percent Above Optimized Alternatives, and the 25 Percent Below Optimized Alternative would generate a 2015 standard that falls below the Optimized Alternative by the same absolute amount by which the 25 Percent Above Optimized Alternative exceeds the Optimized Alternative.

**Table S-1**

**Reference Case Alternative CAFE Standards in MY 2015 MPG**

| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
|---|---|---|---|---|---|---|---|
| | No Action | 25% Below Optimized | Optimized | 25% Above Optimized | 50% Above Optimized | Total Costs Equal Total Benefits | Technology Exhaustion |
| Cars | 27.5 | 33.3 | 33.4 | 33.5 | 33.7 | 33.9 | 47.1 |
| Trucks | 23.4 | 25.8 | 26.0 | 26.2 | 26.5 | 27.0 | 37.2 |

The specific mpg standards associated with each alternative in Table S-1 reflect the Reference Case input values for fuel prices, the social cost of carbon, the discount rate, and oil import externalities. Table S-2 lists the Reference Case and High Scenario values for key economic model inputs. Table S-3 shows how the mpg standards associated with each alternative would change with this combination of inputs. Chapter 2 of this FEIS provides a more detailed description of the Input Scenarios used in the analysis**.**

The alternatives in Tables S-1 and S-3 are both defined by the same relationship between costs and benefits calculated by the economic model. The specific mpg standards associated with the alternatives in Tables S-1 and S-3 differ because model input values affect the relationship between costs and benefits. For example, the Optimized Alternative that yields the greatest net benefits is associated with the specific mpg standards of 33.4 for cars and 26.0 for trucks in MY 2015, as shown in Table S-1, based on the Reference Case inputs in Table S-2. For the High Scenario, the Optimized Alternative that yields the greatest net benefits is associated with the specific mpg standards of 37.7 for cars and 29.6 for trucks in MY 2015, as shown in Table S-3.

**Table S-2**

**Reference Case and High Scenario Economic Model Inputs**

| | Value of Carbon Dioxide ($CO_2$) (2007 $/ton) | Oil Import Externalities (2007 $/gallon) | *Annual Energy Outlook 2008* a/ Fuel Price | Discount Rate |
|---|---|---|---|---|
| Reference Case | $2.00 (domestic) | $0.326 | $2.41 (reference) | 3% $CO_2$ – 7% Other |
| High Scenario | $33.00 (global) | $0.116 | $3.33 (high) | 3% $CO_2$ – 3% Other |

a/ Both the Reference and High *Annual Energy Outlook* fuel price vary by year. Price shown is the average 2011-2030 price for gasoline expressed in 2007 dollars.

**Table S-3**

**High Scenario Alternative CAFE Standards in MY 2015 MPG**

| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
|---|---|---|---|---|---|---|---|
| | No Action | 25% Below Optimized | Optimized (Preferred) | 25% Above Optimized | 50% Above Optimized | Total Costs Equal Total Benefits | Technology Exhaustion |
| Passenger Cars | 27.5 | 37.2 | 37.7 | 38.2 | 38.8 | 39.8 | 47.1 |
| Light Trucks | 23.4 | 28.9 | 29.6 | 30.3 | 31.0 | 32.3 | 37.2 |

An infinite number of mpg standards could theoretically be defined along a continuum from the least to the most stringent levels of CAFE standards. NHTSA selected the specific alternatives analyzed to illustrate cost and benefit characteristics along this continuum. A vast number of model input values also could be used to analyze costs and benefits (along a continuum from low to high values for fuel price, carbon dioxide ($CO_2$), oil import externalities, and the discount rate), serving as model parameters to these existing alternatives and generating additional mpg levels for analysis.[2] These model parameters are estimated forecasts of future economic circumstances. NHTSA acknowledges that these estimates are subject to uncertainty and debate. Many who commented on the DEIS noted that a combination of different model input values would result in substantially higher mpg standards associated with the Optimized Alternative. In this FEIS, NHTSA addresses uncertainty about model input values by presenting analytical results for the Reference Case and High Scenario model inputs, and for two other scenarios with model inputs that fall between these (the Mid-1 and Mid-2 Scenarios).

The resource sections in Chapters 3 and 4 of this FEIS discuss the analysis of alternatives for the Reference Case model inputs under the heading "Environmental Consequences." The Reference Case discussions are followed by sections entitled "Input Scenarios," which discuss the impacts for the same alternatives under the High Scenario, and for other scenarios that have model inputs and outputs that fall between those of the Reference Case and High Scenario (the Mid-1 and Mid-2 Scenarios). This analytical structure is designed to fully inform decisionmakers and the public about the potential environmental impacts of any combination of economic inputs into the model, across the range of feasible alternatives.

[2] CEQ guidance instructs that "[w]hen there are potentially a very large number of alternatives, only a reasonable number of examples, covering the full spectrum of alternatives, must be analyzed and compared in the EIS." CEQ, *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations*, 46 *FR* 18026, 18027, March 23, 1981 (emphasis in original).

## S.5 POTENTIAL ENVIRONMENTAL CONSEQUENCES

This FEIS describes potential environmental impacts to a variety of resources. The resource areas that warrant the most detailed analysis are energy resources, air quality, and climate and resources that might be affected by changes in climate. Tables and figures in this section summarize the direct, indirect, and cumulative effects of the CAFE alternatives on energy, air quality, and climate. NHTSA recognizes the national interest in global climate change issues, particularly as related to the Country's use of automobiles and light trucks. "Global climate change" refers to long-term fluctuations in global surface temperatures, precipitation, sea level, cloud cover, ocean temperatures and currents, and other climatic conditions. Scientific research has shown that in the past century, Earth's surface temperature has risen by an average of about 1.3 degrees Fahrenheit (°F) (0.74 degree Celsius[°C]) (IPCC 2007c) and sea levels have risen 6.7 inches (0.17 meter) (IPCC 2007c).

Most scientists now agree that climate change is very likely due to greenhouse gas (GHG) emissions from human activities (IPCC 2007d). Most GHGs are naturally occurring, including $CO_2$, methane ($CH_4$), nitrous oxide ($N_2O$), water vapor, and ozone ($O_3$). Human activities, such as the combustion of fossil fuel, the production of agricultural commodities, and the harvesting of trees, can contribute to increased concentrations of these gases in the atmosphere.

Levels of atmospheric $CO_2$ have been rising rapidly. For about 10,000 years prior to the Industrial Revolution, atmospheric $CO_2$ levels were 280 ppm (plus or minus 20 ppm). Since the Industrial Revolution, $CO_2$ levels have risen to 367 ppm in 1999 and to 379 ppm in 2005. In addition, other GHGs have been on the increase. Direct atmospheric measurements since 1970 have detected a 150 percent decrease in $CH_4$ and an 18 percent increase in $N_2O$ (IPCC 2007c).

Contributions to the build-up of GHG in the atmosphere vary greatly from country to country, and depend heavily on the level of industrial and economic activity. Emissions from the United States accounted for approximately 15 to 20 percent of global GHG emissions in the year 2000. With more than one-quarter of these U.S. emissions due to the combustion of petroleum fuels in the transportation sector, $CO_2$ emissions from the United States transportation sector represent approximately 4 percent of all global GHG emissions. Emissions from passenger cars and light trucks account for about 60 percent of emissions from the U.S. transportation sector.[3]

Throughout this FEIS, NHTSA has relied extensively on findings of the United Nations Intergovernmental Panel on Climate Change (IPCC) and the U.S. Climate Change Science Program (USCCSP). Our discussion relies heavily on the most recent, thoroughly peer-reviewed, and credible assessments of global climate change and its impact on the United States: the IPCC Fourth Assessment Report Working Group I[4] and II[5] Reports,[6] and reports by the USCCSP that include *Scientific Assessments of the Effects of Global Climate Change on the United States* and Synthesis and Assessment Products.[7] This FEIS cites these sources and the studies they review frequently. For these reasons, NHTSA encourages readers to read the Synthesis Report: Summary for Policymakers of the IPCC Fourth

[3] Estimation of this number is complicated by the fact that greenhouse gas inventories are taken by EPA, but EPA uses different definitions of passenger cars and light trucks than EPCA.
[4] *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC.* ISBN 978 0521 88009-1 Hardback; 978 0521 70596-7. *See* http://www.ipcc.ch/ipccreports/ar4-wg1.htm.
[5] *Climate Change 2007 – Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC.* (978 0521 88010-7 Hardback; 978 0521 70597-4 Paperback). *See* http://www.ipcc.ch/ipccreports/ar4-wg2.htm.
[6] *See generally* http://www.ipcc.ch/ipccreports/assessments-reports.htm.
[7] *See generally* http://www.climatescience.gov/.

Assessment Report before reading this FEIS.[8] This relatively short document summarizes the key findings of the IPCC Fourth Assessment Report.

Because of the link between the transportation sector and GHG emissions, NHTSA recognizes the need to consider the possible impacts on climate and global climate change in the analysis of the effects of these fuel economy standards. NHTSA also recognizes the difficulties and uncertainties involved in such an impact analysis. Accordingly, consistent with CEQ regulations on addressing incomplete or unavailable information in environmental impact analyses, NHTSA has reviewed existing credible scientific evidence which is relevant to this analysis and summarized it in this FEIS. NHTSA has also employed and summarized the results of research models generally accepted in the scientific community.

NHTSA emphasizes that the action of setting fuel economy requirements does not directly regulate emissions from passenger cars and light trucks. NHTSA's authority to promulgate new fuel economy standards is a limited authority and does not allow it to regulate other factors affecting emissions, including society's driving habits. The proposed action before NHTSA is to establish the CAFE standards for MY 2011-2015 passenger cars and light trucks, which has a primary goal of energy conservation. At the same time, the reduction of $CO_2$ emissions is a substantial by-product of that conservation. Further, the stringency of the fuel economy standards is based on the valuation of both direct (fuel savings) and indirect (*e.g.*, the reduction of $CO_2$ emissions) benefits. To the extent that the CAFE standards reduce fuel consumption, they play a role in reducing vehicle emissions that would have occurred absent such conservation. Consequently, as discussed in this FEIS, the proposed action will indirectly contribute to reducing impacts on and associated with the ongoing process of global climate change.

Although the alternatives have the potential to substantially decrease GHG emissions, they do not prevent climate change, but only result in reductions in the anticipated increases in $CO_2$ concentrations, temperature, precipitation, and sea level. They would also to a small degree delay the point at which certain temperature increases and other physical effects stemming from increased GHG emissions would occur. As discussed below, NHTSA presumes that these reductions in climate effects will be reflected in reduced impacts on affected resources.

NHTSA informed the public through notices in the *Federal Register* of its intent to prepare a DEIS for this proposed action. The purpose of these notices was to request from the public its views and comments on the scope of the NEPA analysis, including the impacts and alternatives the DEIS should address, and to inform NHTSA of any available studies that would assist in the impact analysis for global climate-change issues. NHTSA reviewed and considered the public scoping comments and the studies commenters suggested. The predominant request by commenters during the scoping process was that NHTSA focus the DEIS on the standards' possible impacts on both air quality and global climate change.

EPA issued the Notice of Availability of the DEIS on July 3, 2008, which initiated a 45-day public comment period. NHTSA held a public hearing on the DEIS in Washington, DC, on August 4, 2008. The DEIS public comment period ended on August 18, 2008. NHTSA received 66 written comment documents from interested stakeholders. In addition, 44 private citizens and organizations provided oral statements at the public hearing.

[8] IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IPCC*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22, *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf.

Commenters urged NHTSA to consider standards that would go beyond the Energy Independence and Security Act's minimum requirement to reach 35 mpg by the year 2020. NHTSA has analyzed a full range of alternatives, the most stringent of which exceed the 35 mpg target by 2015. Commenters also noted that environmental impacts could depend on the choice of economic inputs used in the Volpe model. NHTSA has addressed these concerns by analyzing the full range of environmental impacts that result under varying economic inputs for each alternative. Finally, commenters requested that the FEIS discuss the appropriate context of this action in relation to other large-scale actions that reduce GHGs, and NHTSA has included such a discussion in this FEIS.

NHTSA consulted with various federal agencies in the development of this FEIS, including the EPA, the Centers for Disease Control and Prevention, the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, the National Park Service, and the U.S. Forest Service.

While the main focus of this FEIS is the quantification of impacts to energy, air quality, and climate, and qualitative analysis of cumulative impacts resulting from climate change, it also addresses other potentially affected resources. NHTSA conducted a qualitative review of the related direct, indirect, and cumulative impacts, positive or negative, of the alternatives on other potentially affected resources (water resources, biological resources, land use, hazardous materials, safety, noise, historic and cultural resources, and environmental justice). Effects of the alternatives on these resources would be too small to address quantitatively. Impacts to biological resources could include reductions in habitat disturbance, decreased impacts from acid rain on water and terrestrial habitats from decreases in petroleum production, and increased agricultural-related disturbances and runoff due to biofuel production. Impacts to land use and development could include increased agricultural land use. Impacts to safety could include downweighting of vehicles and increased vehicle miles traveled, resulting in increased traffic injuries and fatalities. Impacts to hazardous materials could include overall reductions in the generation of air and oil production related wastes, and increases in agricultural wastes due to biofuel production. Impacts to historic and cultural resources could include reductions in acid rain related damage. Noise impacts could include increased noise levels in some areas due to higher vehicle miles traveled. Impacts to environmental justice populations could include increased air toxics in some areas as a result of higher vehicle miles traveled. No impacts are expected to natural areas protected under Section 4(f) of the Department of Transportation Act. In addition, NHTSA has determined a Section 7 review under the Endangered Species Act is not required.

The effects of the alternatives on climate – $CO_2$ concentrations, temperature, precipitation, and sea-level rise – can translate into impacts on key resources, including freshwater resources, terrestrial ecosystems, coastal ecosystems, land use, human health, and environmental justice. Although the alternatives have the potential to substantially decrease GHG emissions, they do not prevent climate change from occurring. However, the magnitudes of the changes in these climate effects under the alternatives – a few parts per million of $CO_2$, one or two one-hundredths of a degree Celsius difference in temperature, a small percentage change (0.02 percent to 0.03 percent) in the rate of precipitation increase, and 1 or 2 millimeters of sea-level change – are too small to meaningfully address quantitatively in terms of their impacts on resources. Given the enormous resource values at stake, these distinctions could be important – very small percentages of huge numbers can still yield substantial results – but they are too small for current quantitative techniques to resolve. Consequently, the discussion of resource impacts does not distinguish among the CAFE alternatives, but rather provides a qualitative review of the benefits of reducing GHG emissions and the magnitude of the risks involved in climate change.[9]

[9] *See* 42 U.S.C. § 4332 (requiring federal agencies to "identify and develop methods and procedures … which will insure that presently unquantified environmental amenities and values may be given appropriate consideration"); 40

NHTSA examined the impacts resulting from global climate change due to all global emissions on the U.S. and global scale. Impacts to freshwater resources could include changes in precipitation patterns, decreasing aquifer recharge in some locations, changes in snowpack and time of snowmelt, salt-water intrusion from ocean rise, changes in weather patterns resulting in flooding or drought in certain regions, increased water temperature, and numerous other changes to freshwater systems that disrupt human use and natural aquatic habitats. Impacts to terrestrial ecosystems could include shifts in species range and migration patterns, potential extinctions of sensitive species unable to adapt to changing conditions, increases in the occurrence of forest fires and pest infestation and intensity, and changes in habitat productivity because of increased atmospheric $CO_2$. Impacts to coastal ecosystems, primarily from predicted sea-level rise, could include the loss of coastal areas due to submersion and erosion, additional impacts from severe weather and storm surges, and increased salinization of estuaries and freshwater aquifers. Impacts to land use could include flooding and severe-weather impacts to coastal, floodplain and island settlements, extreme heat and cold waves, increases in drought in some locations, and weather/sea-level related disruptions of the service, agricultural, and transportation sectors. Impacts to human health could include increased mortality and morbidity due to excessive heat, increases in respiratory conditions due to poor air quality, increases in water and food-borne diseases, changes to the seasonal patterns of vector-borne diseases, and increases in malnutrition. Impacts to environmental justice populations could come from any of the above.

### S.5.1 Direct and Indirect Effects

Under NEPA, direct effects "are caused by the action and occur at the same time and place" (40 CFR § 1508.8). CEQ regulations define indirect effects as those that "are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable. Indirect effects may include … effects on air and water and other natural systems, including ecosystems" (40 CFR § 1508.8). Below is a description of the direct and indirect effects of the CAFE alternatives on energy, air quality, and climate.

#### S.5.1.1 Energy – Reference Case

Table S-4 shows the impact on annual fuel consumption under the Reference Case for passenger cars and light trucks from 2020 through 2060,[10] a period during which an increasing volume of the fleet will be MY 2011-2015 vehicles. The table shows annual total fuel consumption (both gasoline and diesel) under the No Action Alternative and the six action alternatives for the Reference Case. Fuel consumption under the No Action Alternative is 264.9 billion gallons in 2060. Consumption falls to under 256.3 billion gallons under the Optimized Alternative and would fall to 214.3 billion gallons under the Technology Exhaustion Alternative.

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CFR § 1502.23 (requiring an EIS to discuss the relationship between a cost-benefit analysis and any analyses of unquantified environmental impacts, values, and amenities); CEQ, *Considering Cumulative Effects Under the National Environmental Policy Act* (1984), *available at* http://ceq.hss.doe.gov/nepa/ccenepa/ccenepa.htm (recognizing that agencies are sometimes "limited to qualitative evaluations of effects because cause-and-effect relationships are poorly understood" or cannot be quantified).

[10] NHTSA uses 2060 as the end point for the analysis because it is the time at which 98 percent or more of the operating fleet would be made up of MY 2011-2015 or newer vehicles, thus achieving the maximum fuel savings under this rule.

**Table S-4**

**Reference Case Passenger Car and Light Truck Annual Fuel Consumption and Fuel Savings (billion gallons)**

| | Alternative CAFE Standards for MY 2011-2015 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
| Calendar Year | No Action | 25% Below Optimized | Optimized | 25% Above Optimized | 50% Above Optimized | Total Cost Equal Total Benefit | Technology Exhaustion |
| **Fuel Consumption** | | | | | | | |
| 2020 | 151.8 | 149.4 | 149.2 | 148.7 | 148.4 | 147.8 | 134.9 |
| 2030 | 172.4 | 167.7 | 167.2 | 166.5 | 165.8 | 164.9 | 141.8 |
| 2040 | 198.5 | 192.8 | 192.1 | 191.3 | 190.4 | 189.3 | 161.1 |
| 2050 | 229.7 | 222.9 | 222.2 | 221.2 | 220.1 | 218.7 | 185.9 |
| 2060 | 264.9 | 257.1 | 256.3 | 255.1 | 253.8 | 252.3 | 214.3 |
| **Fuel Savings Compared to No Action** | | | | | | | |
| 2020 | -- | 2.4 | 2.6 | 3.1 | 3.4 | 3.9 | 16.9 |
| 2030 | -- | 4.7 | 5.2 | 5.8 | 6.6 | 7.5 | 30.5 |
| 2040 | -- | 5.8 | 6.4 | 7.2 | 8.2 | 9.2 | 37.4 |
| 2050 | -- | 6.8 | 7.4 | 8.5 | 9.5 | 10.8 | 43.8 |
| 2060 | -- | 7.8 | 8.6 | 9.7 | 11.0 | 12.5 | 50.5 |

### S.5.1.2 Energy – Input Scenarios

In response to public comments, and to test how different economic assumptions could affect estimates of fuel consumption, NHTSA examined scenarios that varied cost inputs used in the Volpe model. NHTSA modeled three additional scenarios – High, Mid-1, and Mid-2 – and compared the results to the Reference Case. Table S-5 lists the impact on annual fuel consumption under the High Scenario in the Volpe model for passenger cars and light trucks from 2020 through 2060. The High Scenario uses the economic inputs described in Table S-2. Table S-5 lists annual total fuel consumption for passenger cars and light trucks, both gasoline and diesel, under the No Action Alternative and the six action alternatives. Fuel consumption under the No Action Alternative will reach 230.8 billion gallons by 2060, when the entire fleet is likely to be composed of MY 2011 or newer cars. With the assumption of higher fuel prices, lower consumption is expected across the alternatives. Consumption totals 210.2 billion gallons under the High Scenario Optimized Alternative in 2060, compared to 256.3 billion gallons under the Reference Case Optimized Alternative.

**Table S-5**

**High Scenario Passenger Car and Light Truck Annual Fuel Consumption and Fuel Savings (billion gallons)**

| | Alternative CAFE Standards for MY 2011-2015 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
| Calendar Year | No Action | 25% Below Optimized | Optimized | 25% Above Optimized | 50% Above Optimized | Total Cost Equal Total Benefit | Technology Exhaustion |
| **Fuel Consumption** | | | | | | | |
| 2020 | 139.1 | 133.4 | 132.4 | 131.4 | 130.5 | 129.6 | 123.7 |
| 2030 | 155.4 | 144.4 | 142.6 | 140.8 | 139.5 | 138.2 | 127.8 |
| 2040 | 177.2 | 163.7 | 161.6 | 159.5 | 157.7 | 156.3 | 143.8 |
| 2050 | 202.6 | 187.0 | 184.6 | 182.1 | 180.1 | 178.5 | 164.0 |
| 2060 | 230.8 | 213.0 | 210.2 | 207.4 | 205.1 | 203.1 | 186.7 |

| Table S-5 (cont'd)<br>High Scenario Passenger Car and Light Truck Annual Fuel Consumption and Fuel Savings (billion gallons) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Alternative CAFE Standards for MY 2011-2015 | | | | | | |
| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
| Calendar Year | No Action | 25% Below Optimized | Optimized | 25% Above Optimized | 50% Above Optimized | Total Cost Equal Total Benefit | Technology Exhaustion |
| **Fuel Savings Compared to No Action** | | | | | | | |
| 2020 | -- | 5.6 | 6.7 | 7.8 | 8.6 | 9.4 | 15.5 |
| 2030 | -- | 11.0 | 12.8 | 14.6 | 15.9 | 17.2 | 27.5 |
| 2040 | -- | 13.5 | 15.6 | 17.8 | 19.4 | 20.9 | 33.4 |
| 2050 | -- | 15.5 | 18.0 | 20.6 | 22.5 | 24.2 | 38.6 |
| 2060 | -- | 17.8 | 20.6 | 23.4 | 25.6 | 27.6 | 44.1 |

### S.5.1.3 Air Quality – Reference Case

Table S-6 summarizes the total national criteria and air toxic pollutant emissions in 2035[11] for the seven alternatives under the Reference Case, left to right in order of increasing fuel economy requirements. At the national level, most emissions analyzed in this FEIS are reduced by the Alternatives under the Reference Case, regardless of analysis year. The No Action Alternative has the highest emissions of all the alternatives for oxides of nitrogen ($NO_x$), fine particulate matter ($PM_{2.5}$), sulfur oxides ($SO_x$), volatile organic compounds (VOCs), acetaldehyde, 1,3-butadiene, and diesel particulate matter. Alternative 3 has the highest emissions of all the alternatives for CO and benzene, indicating slight increases over the No Action Alternative. Alternative 7 has the highest emissions of all the alternatives for acrolein and formaldehyde.

### S.5.1.4 Air Quality - Input Scenarios

In response to public comments, and to test how different economic assumptions might affect estimates of air quality impacts, NHTSA modeled three additional scenarios – High, Mid-1, and Mid-2 – and compared the results to the Reference Case. Table S-7 summarizes the national criteria and air toxic pollutant emissions in 2035 for the seven alternatives for the High Scenario. For the High Scenario, emissions under each alternative are generally lower than for the Reference Case. At the national level, most emissions are reduced from the No Action Alternative under the High Scenario, but acetaldehyde and formaldehyde demonstrate increases in some localized cases. These localized increases slightly offset the reductions achieved by implementation of Clean Air Act (CAA) requirements, motor vehicle emissions standards, and related programs. All of the alternatives would reduce adverse health outcomes and health costs related to motor vehicle air pollution, and thus would have beneficial health effects that would not need mitigation.

[11] NHTSA uses 2035 as the latest projection year because by 2035 almost all passenger cars and light trucks in operation would meet at least the MY 2011-2015 standards, and the impact of the standards would start to come only from VMT growth rather than further tightening of the standards. NHTSA believes the year 2035 is a practical maximum for impacts of criteria and toxic air pollutants to be considered reasonably foreseeable rather than speculative.

**Table S-6**

**Reference Case Alternative CAFE Standards Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year, Calendar Year 2035)**

| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
|---|---|---|---|---|---|---|---|
| | **No Action** | **25% Below Optimized** | **Optimized** | **25% Above Optimized** | **50% Above Optimized** | **Total Costs Equal Total Benefits** | **Technology Exhaustion** |
| **Criteria Pollutant Emissions** | | | | | | | |
| Carbon monoxide (CO) | 19,745,847 | 19,809,449 | 19,866,650 | 19,460,737 | 19,411,428 | 19,219,623 | 11,050,380 |
| Nitrogen oxides ($NO_x$) | 1,369,135 | 1,360,018 | 1,360,519 | 1,347,773 | 1,344,759 | 1,336,616 | 1,057,996 |
| Particulate matter ($PM_{2.5}$) | 99,707 | 98,692 | 98,625 | 98,064 | 97,853 | 97,861 | 91,101 |
| Sulfur oxides ($SO_x$) | 265,792 | 259,517 | 258,951 | 257,164 | 255,984 | 254,228 | 203,047 |
| Volatile organic compounds (VOCs) | 1,906,119 | 1,894,399 | 1,896,272 | 1,869,506 | 1,863,351 | 1,844,280 | 1,205,722 |
| **Toxic Air Pollutant Emissions** | | | | | | | |
| Acetaldehyde | 8,209 | 8,206 | 8,208 | 8,198 | 8,197 | 8,165 | 7,733 |
| Acrolein | 351 | 354 | 353 | 367 | 369 | 378 | 720 |
| Benzene | 47,515 | 47,428 | 47,517 | 46,703 | 46,570 | 46,154 | 29,324 |
| 1,3-butadiene | 3,885 | 3,834 | 3,834 | 3,818 | 3,815 | 3,781 | 3,231 |
| Diesel particulate matter (DPM) | 119,499 | 116,161 | 115,786 | 115,400 | 114,858 | 114,592 | 104,644 |
| Formaldehyde | 13,035 | 12,949 | 12,915 | 13,122 | 13,142 | 13,169 | 16,745 |

**Table S-7**

**High Scenario Alternative CAFE Standards Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year, Calendar Year 2035)**

| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
|---|---|---|---|---|---|---|---|
| | **No Action** | **25% Below Optimized** | **Optimized** | **25% Above Optimized** | **50% Above Optimized** | **Total Costs Equal Total Benefits** | **Technology Exhaustion** |
| **Criteria Pollutant Emissions** | | | | | | | |
| Carbon monoxide (CO) | 17,713,991 | 16,946,492 | 17,052,955 | 16,475,978 | 16,127,830 | 15,629,753 | 9,913,291 |
| Nitrogen oxides ($NO_x$) | 1,228,251 | 1,181,455 | 1,180,414 | 1,159,073 | 1,146,599 | 1,129,532 | 949,127 |
| Particulate matter ($PM_{2.5}$) | 89,447 | 86,654 | 86,251 | 86,389 | 85,756 | 85,318 | 81,727 |
| Sulfur oxides ($SO_x$) | 238,442 | 221,475 | 219,361 | 215,533 | 212,881 | 209,978 | 182,153 |
| Volatile organic compounds (VOCs) | 1,709,979 | 1,620,442 | 1,621,526 | 1,572,211 | 1,546,659 | 1,507,558 | 1,081,653 |
| **Toxic Air Pollutant Emissions** | | | | | | | |
| Acetaldehyde | 7,364 | 7,318 | 7,326 | 7,244 | 7,239 | 7,211 | 6,938 |
| Acrolein | 315 | 356 | 353 | 379 | 393 | 412 | 646 |
| Benzene | 42,626 | 40,639 | 40,753 | 39,588 | 38,860 | 37,822 | 26,306 |
| 1,3-butadiene | 3,885 | 3,815 | 3,821 | 3,790 | 3,754 | 3,709 | 3,231 |
| Diesel particulate matter (DPM) | 107,203 | 99,856 | 98,495 | 98,385 | 97,499 | 96,932 | 93,876 |
| Formaldehyde | 11,694 | 11,933 | 11,878 | 12,000 | 12,178 | 12,394 | 15,022 |

### S.5.1.5 Climate – Reference Case GHG Emissions

Table S-8 shows total GHG emissions and emissions reductions from new passenger cars and light trucks from 2010-2100[12] under each of the seven alternatives for the Reference Case. While GHG emissions from this sector will continue to rise over the period (absent other reduction efforts), the effect of the alternatives is to slow this increase by varying amounts. Compared to the No Action Alternative, projections of emissions reductions over the 2010 to 2100 time frame due to other MY 2011-2015 alternative CAFE standards ranged from 5,922 to 28,047 million metric tons of $CO_2$ ($MMTCO_2$).[13] Over this period, this range of alternatives would reduce global $CO_2$ emissions (from all sources) by about 0.1 to 0.6 percent (based on global emissions of 4,850,000 $MMTCO_2$).

**Table S-8**

**Reference Case Emissions and Emissions Reductions Due to the MY 2011-2015 CAFE Standards from 2010-2100 ($MMTCO_2$)**

| Alternative | Emissions | Emissions Reductions Compared to No Action Alternative |
|---|---|---|
| 1 No Action | 221,258 | 0 |
| 2 25 Percent Below Optimized | 215,337 | 5,922 |
| 3 Optimized | 214,643 | 6,616 |
| 4 25 Percent Above Optimized | 214,144 | 7,114 |
| 5 50 Percent Above Optimized | 213,254 | 8,004 |
| 6 Total Costs Equal Total Benefits | 212,345 | 8,913 |
| 7 Technology Exhaustion | 193,212 | 28,047 |

### S.5.1.6 Climate - Reference Case $CO_2$ Concentration and Global Mean Surface Temperature

This FEIS uses a climate model to estimate the changes in $CO_2$ concentrations, global mean surface temperature, and changes in sea level for each alternate CAFE standard, and uses increases in global mean surface temperature combined with an approach and coefficients from the IPCC Fourth Assessment Report (IPCC 2007a) to estimate changes in global precipitation. NHTSA used MAGICC (Model for the Assessment of Greenhouse-gas Induced Climate Change) Version 5.3 (Wigley 2003 to 2008) to estimate changes in key direct and indirect effects. The application of MAGICC version 5.3 uses the emissions estimates from the Volpe model, which include $CO_2$, $CH_4$, and $N_2O$ from both direct fuel combustion and upstream sources, as well as $SO_2$, $NO_x$, CO, and VOCs. NHTSA performed sensitivity analyses to examine the relationship among various CAFE alternatives, climate sensitivities, and scenarios of global emissions paths and the associated direct and indirect effects for each combination. These relationships can be used to infer the effect of the emissions associated with the regulatory alternatives on direct and indirect climate effects.

[12] The global climate change models NHTSA used for this FEIS analysis use 2100 because we believe that, given the present state of the science, 2100 is a practical maximum for impacts of climate change to be considered reasonably foreseeable rather than speculative.

[13] The values here are summed from 2010 through 2100, and therefore are considerably higher than the value of 520 $MMTCO_2$ cited in the Notice of Proposed Rulemaking for the Optimized Alternative. The latter value is the reduction in $CO_2$ emissions by only MY 2011-2015 passenger cars and light trucks over their lifetimes resulting from the optimized CAFE standards, measured as a reduction from the Notice of Proposed Rulemaking baseline of extending the CAFE standards for MY 2010 to apply to MY 2011-2015.

Table S-9 shows mid-range estimated $CO_2$ concentrations, increase in global mean surface temperature, and sea-level rise in 2030, 2060, and 2100 under the No Action Alternative and the six action alternatives. There is a fairly narrow band of estimated $CO_2$ concentrations as of 2100, from 714.6 parts per million under the Technology Exhaustion Alternative to 717.2 parts per million under the No Action Alternative. Because $CO_2$ concentrations are the key driver of climate effects, this narrow range implies that the differences among alternatives are difficult to distinguish. These estimates include considerable uncertainty due to a number of factors, of which the climate sensitivity is the most important. The IPCC Fourth Assessment Report estimates a range of climate sensitivity from 2.5 to 4.0 °C with a mid point of 3.0 °C which directly relates to the uncertainty in estimated global mean surface temperature.

**Table S-9**

**Reference Case MY 2011-2015 Alternative CAFE Standards Impact on $CO_2$ Concentration, Global Mean Surface Temperature Increase, and Sea-level Rise in 2100 Using MAGICC (A1B a/)**

| | $CO_2$ Concentration (parts per million) | | | Global Mean Surface Temperature Increase (°C) | | | Sea-level Rise (centimeters) | | |
|---|---|---|---|---|---|---|---|---|---|
| | **2030** | **2060** | **2100** | **2030** | **2060** | **2100** | **2030** | **2060** | **2100** |
| **Totals by Alternative** | | | | | | | | | |
| 1 No Action (A1B-AIM) | 455.5 | 573.7 | 717.2 | 0.874 | 1.944 | 2.959 | 7.99 | 19.30 | 37.10 |
| 2 25 Percent Below Optimized | 455.5 | 573.4 | 716.7 | 0.873 | 1.943 | 2.957 | 7.99 | 19.29 | 37.08 |
| 3 Optimized | 455.5 | 573.4 | 716.6 | 0.873 | 1.943 | 2.956 | 7.99 | 19.29 | 37.08 |
| 4 25 Percent Above Optimized | 455.5 | 573.4 | 716.6 | 0.873 | 1.943 | 2.956 | 7.99 | 19.29 | 37.08 |
| 5 50 Percent Above Optimized | 455.5 | 573.4 | 716.5 | 0.873 | 1.943 | 2.956 | 7.99 | 19.29 | 37.08 |
| 6 Total Costs Equal Total Benefits | 455.4 | 573.3 | 716.4 | 0.873 | 1.943 | 2.956 | 7.99 | 19.28 | 37.07 |
| 7 Technology Exhaustion | 455.3 | 572.5 | 714.6 | 0.872 | 1.938 | 2.946 | 7.99 | 19.25 | 36.99 |
| **Reductions under Alternative CAFE Standards** | | | | | | | | | |
| 2 25 Percent Below Optimized | 0.0 | 0.3 | 0.5 | 0.000 | 0.001 | 0.002 | 0.00 | 0.01 | 0.02 |
| 3 Optimized | 0.0 | 0.3 | 0.6 | 0.000 | 0.001 | 0.002 | 0.00 | 0.01 | 0.02 |
| 4 25 Percent Above Optimized | 0.0 | 0.3 | 0.6 | 0.000 | 0.001 | 0.003 | 0.00 | 0.01 | 0.02 |
| 5 50 Percent Above Optimized | 0.0 | 0.3 | 0.7 | 0.000 | 0.001 | 0.003 | 0.00 | 0.01 | 0.02 |
| 6 Total Costs Equal Total Benefits | 0.1 | 0.4 | 0.8 | 0.000 | 0.002 | 0.003 | 0.00 | 0.02 | 0.03 |
| 7 Technology Exhaustion | 0.2 | 1.2 | 2.6 | 0.002 | 0.007 | 0.013 | 0.00 | 0.05 | 0.11 |

a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

For all alternatives, the temperature increase is about 0.87 °C for 2030, 1.94 °C for 2060, and 2.96 °C for 2100. The differences among alternatives are small. For 2100, the reduction in temperature increase in relation to the No Action Alternative ranges from 0.002 °C to 0.013 °C.

### S.5.1.7 Climate - Reference Case Global Mean Precipitation

The action alternatives reduce temperature increases slightly in relation to the No Action Alternative, and thus reduce increases in precipitation slightly, as shown in Table S-10. As shown in the table, there is a fairly narrow band of estimated reductions in precipitation increase in the mid-range estimates as of 2090, from 4.49 percent to 4.51 percent, and there is very little difference between the alternatives. Uncertainty in these numbers results from uncertainty in the increase in the global mean surface temperature and uncertainty in the global mean precipitation change.

**Table S-10**

**Reference Case MY 2011-2015 CAFE Alternatives: Impact on Reductions in Global Mean Precipitation based on A1B a/ SRES Scenario Using Increases in Global Mean Surface Temperature Simulated by MAGICC**

| Scenario | 2020 | 2055 | 2090 |
|---|---|---|---|
| **Global Mean Precipitation Change** | | | |
| | 1.45 | 1.51 | 1.63 |
| **Global Temperature above Average 1980-1999, Mid-level Results ($^oC$)** | | | |
| 1 No Action | 0.560 | 1.764 | 2.765 |
| 2 25 Percent Below Optimized | 0.560 | 1.763 | 2.763 |
| 3 Optimized | 0.560 | 1.763 | 2.763 |
| 4 25 Percent Above Optimized | 0.560 | 1.763 | 2.762 |
| 5 50 Percent Above Optimized | 0.560 | 1.763 | 2.762 |
| 6 Total Costs Equal Total Benefits | 0.560 | 1.763 | 2.762 |
| 7 Technology Exhaustion | 0.560 | 1.758 | 2.753 |
| **Reduction in Global Temperature, Mid-level Results, Compared to No Action ($^oC$)** | | | |
| 2 25 Percent Below Optimized | 0.000 | 0.001 | 0.002 |
| 3 Optimized | 0.000 | 0.001 | 0.002 |
| 4 25 Percent Above Optimized | 0.000 | 0.001 | 0.002 |
| 5 50 Percent Above Optimized | 0.000 | 0.001 | 0.003 |
| 6 Total Costs Equal Total Benefits | 0.000 | 0.001 | 0.003 |
| 7 Technology Exhaustion | 0.000 | 0.006 | 0.011 |
| **Global Mean Precipitation Change, Mid-level Results (%)** | | | |
| 1 No Action | 0.81 | 2.66 | 4.51 |
| 2 25 Percent Below Optimized | 0.81 | 2.66 | 4.50 |
| 3 Optimized | 0.81 | 2.66 | 4.50 |
| 4 25 Percent Above Optimized | 0.81 | 2.66 | 4.50 |
| 5 50 Percent Above Optimized | 0.81 | 2.66 | 4.50 |
| 6 Total Costs Equal Total Benefits | 0.81 | 2.66 | 4.50 |
| 7 Technology Exhaustion | 0.81 | 2.65 | 4.49 |
| **Reduction in Global Mean Precipitation Change, Mid-level Results, Compared to No Action (%)** | | | |
| 2 25 Percent Below Optimized | 0.00 | 0.00 | 0.00 |
| 3 Optimized | 0.00 | 0.00 | 0.00 |
| 4 25 Percent Above Optimized | 0.00 | 0.00 | 0.00 |
| 5 50 Percent Above Optimized | 0.00 | 0.00 | 0.00 |
| 6 Total Costs Equal Total Benefits | 0.00 | 0.00 | 0.00 |
| 7 Technology Exhaustion | 0.00 | 0.01 | 0.02 |

a/ The A1B scenario is the SRES marker scenario used by IPCC Working Group I to represent the SRES A1B (medium) storyline.

### S.5.1.8 Climate - Reference Case Impact on Sea-level Rise

The IPCC Fourth Assessment Report identifies four primary components of sea-level rise: thermal expansion of ocean water; melting of glaciers and ice caps; loss of land-based ice in Antarctica; and loss of land-based ice in Greenland. Ice-sheet discharge is an additional factor that could influence sea level over the long term. The MAGICC model calculates the oceanic thermal expansion component of global mean sea-level rise, using a non-linear temperature- and pressure-dependent expansion coefficient. It also addresses the other three primary components through ice-melt models for small glaciers and the Greenland and Antarctic ice sheets, and excludes non-melt sources, which the IPCC Fourth Assessment Report also excluded.

Table S-9 lists the impact on sea-level rise under the scenarios and shows sea-level rise in 2100 ranging from 37.10 centimeters under the No Action Alternative to 36.99 centimeters under the

Technology Exhaustion Alternative, for a maximum reduction of 0.11 centimeter by 2100 from under the CAFE alternatives for the Reference Case.

### S.5.1.9 Climate - Input Scenarios

In response to public comments, and to test how different economic assumptions might affect estimates of emissions reductions and resulting climate effects, NHTSA modeled three additional scenarios – High, Mid-1, and Mid-2 – and compared the results to the Reference Case. Variables that were altered include fuel price, the social cost of carbon, oil import externalities, and the discount rate for other benefits Tables S-11 and S-12 list the results for the High Scenario.

As shown in Table S-11, compared to the Reference Case, total emissions under the High Scenario were lower for all alternatives. The primary reason for this difference is the lower forecast for vehicle miles traveled under the High Scenario. Emissions reductions for all alternatives compared to the No Action Alternative were greater under the High Scenario than under the Reference Case, except for the emissions reduction resulting from the Technology Exhaustion Alternative. There was a greater emissions reduction resulting from the Technology Exhaustion Alternative under the Reference Case than under the High Scenario.

**Table S-11**

**High Scenario Emissions and Emissions Reductions Due to the MY 2011-2015 CAFE Standards from 2010-2100 ($MMTCO_2$)**

| Alternative | Emissions | Emissions Reductions Compared to No Action Alternative |
|---|---|---|
| 1 No Action | 195,501 | 0 |
| 2 25 Percent Below Optimized | 182,890 | 12,611 |
| 3 Optimized | 180,591 | 14,910 |
| 4 25 Percent Above Optimized | 179,079 | 16,422 |
| 5 50 Percent Above Optimized | 177,669 | 17,832 |
| 6 Total Costs Equal Total Benefits | 176,736 | 18,765 |
| 7 Technology Exhaustion | 170,829 | 24,672 |

Table S-12 shows the resulting effects on $CO_2$ concentration, global mean surface temperature, and sea-level rise. Under the High Scenario, the resulting $CO_2$ concentration, global mean surface temperature, and sea-level rise were lower than under the Reference Case for all action alternatives except the Technology Exhaustion Alternative. Thus, the differences for the action alternatives compared to the No Action Alternative are greater for the High Scenario than the Reference Case, except for the Technology Exhaustion Alternative.

**Table S-12**

**High Scenario 2011-2015 CAFE Alternatives Impact on $CO_2$ Concentrations, Global Mean Surface Temperature Increase, and Sea-level Rise in 2100 Using MAGICC (A1B a/)**

| Totals by Alternative | $CO_2$ Concentration (parts per million) | | | Global Mean Surface Temperature Increase (°C) | | | Sea-level Rise (centimeters) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2030 | 2060 | 2100 | 2030 | 2060 | 2100 | 2030 | 2060 | 2100 |
| 1 No Action | 455.5 | 573.7 | 717.2 | 0.874 | 1.944 | 2.959 | 7.99 | 19.30 | 37.10 |
| 2 25 Percent Below Optimized | 455.4 | 573.2 | 716.1 | 0.873 | 1.942 | 2.954 | 7.99 | 19.28 | 37.06 |
| 3 Optimized | 455.4 | 573.1 | 715.8 | 0.873 | 1.942 | 2.953 | 7.99 | 19.28 | 37.05 |
| 4 25 Percent Above Optimized | 455.4 | 573.0 | 715.7 | 0.873 | 1.941 | 2.953 | 7.99 | 19.28 | 37.04 |
| 5 50 Percent Above Optimized | 455.4 | 572.9 | 715.6 | 0.873 | 1.941 | 2.952 | 7.99 | 19.27 | 37.04 |
| 6 Total Costs Equal Total Benefits | 455.3 | 572.9 | 715.5 | 0.873 | 1.940 | 2.951 | 7.99 | 19.27 | 37.03 |
| 7 Technology Exhaustion | 455.3 | 572.6 | 714.9 | 0.872 | 1.938 | 2.948 | 7.99 | 19.26 | 37.00 |
| **Reduction under CAFE Alternatives** | | | | | | | | | |
| 2 25 Percent Below Optimized | 0.1 | 0.5 | 1.1 | 0.001 | 0.002 | 0.005 | 0.00 | 0.02 | 0.04 |
| 3 Optimized | 0.1 | 0.6 | 1.4 | 0.001 | 0.003 | 0.006 | 0.00 | 0.02 | 0.05 |
| 4 25 Percent Above Optimized | 0.1 | 0.7 | 1.5 | 0.001 | 0.003 | 0.006 | 0.00 | 0.02 | 0.06 |
| 5 50 Percent Above Optimized | 0.1 | 0.8 | 1.6 | 0.001 | 0.004 | 0.007 | 0.00 | 0.03 | 0.06 |
| 6 Total Costs Equal Total Benefits | 0.2 | 0.8 | 1.7 | 0.001 | 0.004 | 0.008 | 0.00 | 0.03 | 0.07 |
| 7 Technology Exhaustion | 0.2 | 1.1 | 2.3 | 0.002 | 0.006 | 0.011 | 0.00 | 0.04 | 0.10 |

a/ The A1B scenario is the SRES marker scenario used by IPCC Working Group I to represent the SRES A1B (medium) storyline.

## S.5.2 Cumulative Effects

CEQ identifies the impacts that must be addressed and considered by federal agencies in satisfying the requirements of NEPA. These include permanent, temporary, direct, indirect, and cumulative impacts. CEQ regulations implementing the procedural provisions of NEPA define cumulative impacts as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions." 40 CFR § 1508.7. Below is a description of the cumulative effects of the CAFE alternatives on energy, air quality, and climate.

### S.5.2.1 Energy – Reference Case

The seven alternatives examined for CAFE standards will result in different future levels of fuel use, total energy, and petroleum consumption, which will in turn have an impact on emissions of GHG and criteria air pollutants. Table S-13 presents the cumulative fuel consumption and fuel savings of passenger-car and light-truck fleets from the onset of the new CAFE standards for the Reference Case.

**Table S-13**

**Reference Case Passenger Car and Light Truck Cumulative Annual Fuel Consumption and Cumulative Fuel Savings (billion gallons)**

| Calendar Year Range | Alternative CAFE Standards for MY 2011-2020 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
| | No Action | 25% Below Optimized | Optimized | 25% Above Optimized | 50% Above Optimized | Total Cost Equal Total Benefit | Technology Exhaustion |
| **Cumulative Fuel Consumption** | | | | | | | |
| 2010-2020 | 1,601.3 | 1,583.2 | 1,581.8 | 1,579.5 | 1,577.7 | 1,574.5 | 1,510.9 |
| 2010-2030 | 3,229.6 | 3,083.6 | 3,076.0 | 3,063.1 | 3,051.9 | 3,038.5 | 2,786.4 |
| 2010-2040 | 5,092.6 | 4,731.3 | 4,714.0 | 4,684.5 | 4,658.6 | 4,630.4 | 4,125.8 |
| 2010-2050 | 7,245.2 | 6,620.1 | 6,591.1 | 6,541.1 | 6,497.2 | 6,451.1 | 5,647.9 |
| 2010-2060 | 9,733.2 | 8,800.2 | 8,757.5 | 8,683.5 | 8,618.6 | 8,551.6 | 7,401.6 |
| **Cumulative Fuel Savings** | | | | | | | |
| 2010-2020 | -- | 18.1 | 19.5 | 21.8 | 23.6 | 26.7 | 90.3 |
| 2010-2030 | -- | 146.0 | 153.7 | 166.5 | 177.7 | 191.1 | 443.2 |
| 2010-2040 | -- | 361.3 | 378.6 | 408.1 | 434.0 | 462.2 | 966.8 |
| 2010-2050 | -- | 625.1 | 654.1 | 704.1 | 748.0 | 794.1 | 1,597.2 |
| 2010-2060 | -- | 933.1 | 975.7 | 1,049.8 | 1,114.6 | 1,181.6 | 2,331.7 |

### S.5.2.2 Energy - Input Scenarios

To illustrate how different economic assumptions could affect estimates of fuel consumption, NHTSA examined scenarios that varied economic inputs used in the Volpe model. NHTSA modeled three additional scenarios – High, Mid-1, and Mid-2 – and compared the results to the Reference Case. Table S-14 lists the cumulative impact on fuel consumption under the High Scenario in the Volpe model for passenger cars and light trucks from the onset of the new CAFE standards. The High Scenario uses the economic inputs described in Table S-2. The table lists total fuel consumption for passenger cars and light trucks, both gasoline and diesel, under the No Action Alternative and the six action alternatives.

**Table S-14**

**High Scenario Passenger Car and Light Truck Cumulative Annual Fuel Consumption and Cumulative Fuel Savings (billion gallons)**

| Calendar Year Range | Alternative CAFE Standards for MY 2011-2020 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
| | No Action | 25% Below Optimized | Optimized | 25% Above Optimized | 50% Above Optimized | Total Cost Equal Total Benefit | Technology Exhaustion |
| **Cumulative Fuel Consumption** | | | | | | | |
| 2010-2020 | 1,498.6 | 1,464.8 | 1,458.8 | 1,452.6 | 1,447.8 | 1,443.0 | 1,415.4 |
| 2010-2030 | 2,971.5 | 2,738.3 | 2,709.5 | 2,683.5 | 2,660.0 | 2,643.7 | 2,569.1 |
| 2010-2040 | 4,641.6 | 4,086.9 | 4,024.5 | 3,970.4 | 3,919.4 | 3,888.5 | 3,769.9 |
| 2010-2050 | 6,550.8 | 5,608.3 | 5,506.0 | 5,418.6 | 5,334.6 | 5,287.1 | 5,119.9 |
| 2010-2060 | 8,731.1 | 7,341.4 | 7,193.3 | 7,067.6 | 6,945.6 | 6,879.3 | 6,656.6 |
| **Cumulative Fuel Savings** | | | | | | | |
| 2010-2020 | -- | 33.9 | 39.9 | 46.0 | 50.9 | 55.6 | 83.3 |
| 2010-2030 | -- | 233.2 | 262.0 | 288.0 | 311.4 | 327.8 | 402.4 |
| 2010-2040 | -- | 554.7 | 617.1 | 671.2 | 722.2 | 753.2 | 871.8 |
| 2010-2050 | -- | 942.6 | 1,044.9 | 1,132.3 | 1,216.2 | 1,263.8 | 1,430.9 |
| 2010-2060 | -- | 1,389.6 | 1,537.8 | 1,663.5 | 1,785.5 | 1,851.8 | 2,074.5 |

### S.5.2.3 Air Quality – Reference Case

Table S-15 summarizes the cumulative national toxic and criteria pollutants in 2035, showing that the Reference Case No Action Alternative has the highest cumulative emissions of all the alternatives for all pollutants except CO, acetaldehyde, acrolein, and formaldehyde. Alternative 3 has the highest emissions of CO and acetaldehyde. Alternative 7 has the highest emissions of all the alternatives for acrolein[14] and formaldehyde.

### S.5.2.4 Air Quality - Input Scenarios

In response to public comments, and to test how different economic assumptions could affect air quality by examining scenarios with varied economic inputs used in the Volpe model, NHTSA modeled three additional scenarios – High, Mid-1, and Mid-2 – and compared the results to the Reference Case. Table S-16 summarizes the cumulative national criteria and air toxic pollutant emissions in 2035 for the seven alternatives for the High Scenario. For the High Scenario, emissions under each alternative are generally lower than under the Reference Case. There could be localized increases in criteria and toxic air pollutant emissions in some nonattainment areas as a result of implementation of the CAFE standards under the alternatives. These localized increases slightly offset the reductions being achieved by implementation of CAA standards, motor-vehicle emissions standards, and related programs. All of the alternatives would reduce adverse health outcomes and health costs related to motor-vehicle air pollution, and thus would have beneficial health effects that would not need mitigation.

[14] Data on upstream emissions reductions were not available for acrolein. Thus, the emissions for acrolein reflect only the change in tailpipe emissions.

**Table S-15**

**Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year, Calendar Year 2035)**

| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
|---|---|---|---|---|---|---|---|
| | **No Action** | **25% Below Optimized** | **Optimized** | **25% Above Optimized** | **50% Above Optimized** | **Total Costs Equal Total Benefits** | **Technology Exhaustion** |
| **Criteria Pollutant Emissions (Calendar Year 2035)** | | | | | | | |
| Carbon monoxide (CO) | 19,745,847 | 20,068,580 | 20,145,455 | 19,664,457 | 19,615,715 | 19,406,046 | 11,524,825 |
| Nitrogen oxides ($NO_x$) | 1,369,135 | 1,335,125 | 1,335,545 | 1,318,678 | 1,314,728 | 1,305,570 | 1,048,518 |
| Particulate matter ($PM_{2.5}$) | 99,707 | 95,588 | 95,468 | 94,650 | 94,333 | 94,305 | 89,788 |
| Sulfur oxides ($SO_x$) | 265,792 | 240,446 | 239,437 | 236,567 | 234,662 | 232,370 | 183,541 |
| Volatile organic compounds (VOC) | 1,906,119 | 1,861,129 | 1,862,621 | 1,832,904 | 1,825,138 | 1,803,935 | 1,196,950 |
| **Toxic Air Pollutant Emissions (Calendar Year 2035)** | | | | | | | |
| Acetaldehyde | 8,209 | 8,224 | 8,229 | 8,211 | 8,214 | 8,183 | 7,974 |
| Acrolein | 351 | 362 | 361 | 377 | 381 | 392 | 758 |
| Benzene | 47,515 | 47,256 | 47,364 | 46,405 | 46,251 | 45,791 | 29,613 |
| 1,3-butadiene | 3,885 | 3,852 | 3,854 | 3,839 | 3,839 | 3,803 | 3,331 |
| Diesel particulate matter (DPM) | 119,499 | 105,773 | 105,131 | 104,372 | 103,457 | 102,999 | 94,643 |
| Formaldehyde | 13,035 | 12,717 | 12,677 | 12,899 | 12,924 | 12,961 | 17,034 |

**Table S-16**

**High Scenario MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impacts on Nationwide Criteria Pollutant Emissions and Toxic Air Pollutant Emissions from Passenger Cars and Light Trucks (tons/year, Calendar Year 2035)**

| | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 | Alt. 5 | Alt. 6 | Alt. 7 |
|---|---|---|---|---|---|---|---|
| | **No Action** | **25% Below Optimized** | **Optimized** | **25% Above Optimized** | **50% Above Optimized** | **Total Costs Equal Total Benefits** | **Technology Exhaustion** |
| **Criteria Pollutant Emissions (Calendar Year 2035)** | | | | | | | |
| Carbon monoxide (CO) | 17,713,991 | 17,102,067 | 17,249,166 | 16,551,203 | 16,107,699 | 15,482,276 | 10,338,916 |
| Nitrogen oxides ($NO_x$) | 1,228,251 | 1,147,887 | 1,145,748 | 1,120,053 | 1,102,988 | 1,082,932 | 940,625 |
| Particulate matter ($PM_{2.5}$) | 89,447 | 83,017 | 82,423 | 82,542 | 81,642 | 81,247 | 80,549 |
| Sulfur oxides ($SO_x$) | 238,442 | 198,158 | 194,471 | 189,553 | 185,397 | 182,149 | 164,654 |
| Volatile organic compounds (VOCs) | 1,709,979 | 1,575,147 | 1,574,616 | 1,518,089 | 1,486,823 | 1,440,609 | 1,073,784 |
| **Toxic Air Pollutant Emissions (Calendar Year 2035)** | | | | | | | |
| Acetaldehyde | 7,364 | 7,351 | 7,372 | 7,282 | 7,278 | 7,255 | 7,153 |
| Acrolein | 315 | 374 | 374 | 406 | 424 | 450 | 680 |
| Benzene | 42,626 | 40,169 | 40,301 | 38,917 | 37,990 | 36,721 | 26,566 |
| 1,3-butadiene | 3,885 | 3,833 | 3,846 | 3,810 | 3,766 | 3,713 | 3,331 |
| Diesel particulate matter (DPM) | 107,203 | 87,624 | 85,380 | 85,166 | 83,729 | 83,295 | 84,904 |
| Formaldehyde | 11,694 | 11,783 | 11,730 | 11,897 | 12,127 | 12,433 | 15,281 |

### S.5.2.5 Climate - Reference Case Cumulative GHG Emissions

Table S-17 lists total emissions reductions from MY 2010-2100 new passenger cars and light trucks under each of the seven alternatives for the Reference Case. Projections of emissions reductions over the 2010 to 2100 time frame due to the MY 2011-2020 CAFE standards ranged from 24,321 to 49,157 $MMTCO_2$. Compared to global emissions of 4,850,000 $MMTCO_2$ over this period (projected by the IPCC A1B-medium scenario), the incremental impact of this rulemaking is expected to reduce global $CO_2$ emissions by about 0.5 to 1.0 percent.

**Table S-17**

**Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 CAFE Standards Cumulative Emissions and Emissions Reductions Due to the Projected for 2010-2100 ($MMTCO_2$)**

| Alternative | Emissions | Emissions Reductions Compared to No Action Alternative |
|---|---|---|
| 1 No Action | 221,258 | 0 |
| 2 25 Percent Below Optimized | 196,937 | 24,321 |
| 3 Optimized | 195,816 | 25,442 |
| 4 25 Percent Above Optimized | 194,057 | 27,201 |
| 5 50 Percent Above Optimized | 192,478 | 28,780 |
| 6 Total Costs Equal Total Benefits | 191,073 | 30,185 |
| 7 Technology Exhaustion | 172,101 | 49,157 |

### S.5.2.6 Climate - Reference Case $CO_2$ Concentration and Global Mean Surface Temperature

The mid-range results of MAGICC model simulations for the No Action Alternative and the six alternatives in terms of $CO_2$ concentrations and increase in global mean surface temperature in 2030, 2060, and 2100 are presented in Table S-18 and Figures S-1 through S-4. As Figures S-3 and S-4 show, the impact on the growth in $CO_2$ concentrations and temperature is just a fraction of the total growth in $CO_2$ concentrations and global mean surface temperature. However, the relative impact of the CAFE alternatives is illustrated by the reduction in growth of both $CO_2$ concentrations and temperature under the Technology Exhaustion Alternative, which is nearly double that of the 25 Percent Below Optimized Alternative, as shown in Figures S-5 to S-6.

As shown in the table and figures, there is a fairly narrow band of estimated $CO_2$ concentrations as of 2100, from 712.6 parts per million under the most stringent alternative to 717.2 parts per million under the No Action Alternative. Because $CO_2$ concentrations are the key driver climate effects, this narrow range implies that the differences among alternatives are difficult to distinguish. The MAGICC model simulations of mean global surface air temperature increases are also shown in Table S-18. For all alternatives, the temperature increase is about 0.87 °C as of 2030, 1.93 to 1.94 °C as of 2060, and 2.94 to 2.96 °C as of 2100. The differences among alternatives are small. As of 2100, the reduction in temperature increase, in relation to the No Action Alternative, ranges from 0.009 °C to 0.02 °C. These estimates include considerable uncertainty due to a number of factors, of which climate sensitivity is the most important. The IPCC Fourth Assessment Report estimates a range of the climate sensitivity from 2.5 to 4.0 °C with a mid-point of 3.0 °C, which directly relates to the uncertainty in the estimated global mean surface temperature.

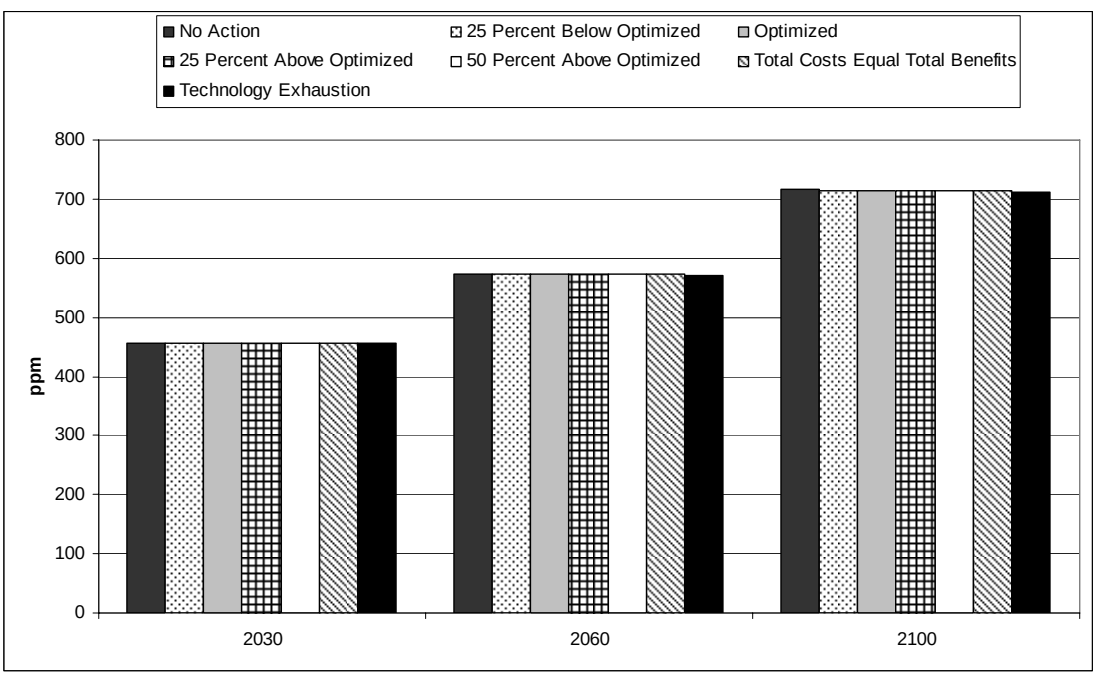
**Table S-18**

**Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on $CO_2$ Concentrations, Surface Temperature Increase, and Sea-level Rise in 2100 Using MAGICC (A1B a/)**

| | $CO_2$ Concentration (parts per million) | | | Surface Temperature Increase ($^oC$) | | | Sea-level Rise (centimeters) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2030 | 2060 | 2100 | 2030 | 2060 | 2100 | 2030 | 2060 | 2100 |
| **Totals by Alternative** | | | | | | | | | |
| 1 No Action (A1B-AIM) | 455.5 | 573.7 | 717.2 | 0.874 | 1.944 | 2.959 | 7.99 | 19.30 | 37.10 |
| 2 25 Percent Below Optimized | 455.4 | 572.7 | 714.9 | 0.873 | 1.940 | 2.950 | 7.99 | 19.27 | 37.02 |
| 3 Optimized | 455.4 | 572.7 | 714.8 | 0.873 | 1.940 | 2.950 | 7.99 | 19.27 | 37.02 |
| 4 25 Percent Above Optimized | 455.3 | 572.6 | 714.7 | 0.873 | 1.940 | 2.949 | 7.99 | 19.27 | 37.01 |
| 5 50 Percent Above Optimized | 455.3 | 572.5 | 714.5 | 0.873 | 1.940 | 2.948 | 7.99 | 19.27 | 37.01 |
| 6 Total Costs Equal Total Benefits | 455.3 | 572.5 | 714.4 | 0.873 | 1.939 | 2.948 | 7.99 | 19.26 | 37.00 |
| 7 Technology Exhaustion | 455.1 | 571.7 | 712.6 | 0.871 | 1.934 | 2.938 | 7.99 | 19.23 | 36.92 |
| **Reduction Compared to No Action** | | | | | | | | | |
| 2 25 Percent Below Optimized | 0.1 | 1.0 | 2.3 | 0.001 | 0.004 | 0.009 | 0.00 | 0.03 | 0.08 |
| 3 Optimized | 0.1 | 1.0 | 2.4 | 0.001 | 0.004 | 0.009 | 0.00 | 0.03 | 0.08 |
| 4 25 Percent Above Optimized | 0.2 | 1.1 | 2.5 | 0.001 | 0.005 | 0.010 | 0.00 | 0.03 | 0.09 |
| 5 50 Percent Above Optimized | 0.2 | 1.2 | 2.7 | 0.001 | 0.005 | 0.011 | 0.00 | 0.03 | 0.09 |
| 6 Total Costs Equal Total Benefits | 0.2 | 1.2 | 2.8 | 0.001 | 0.005 | 0.011 | 0.00 | 0.04 | 0.10 |
| 7 Technology Exhaustion | 0.4 | 2.0 | 4.6 | 0.002 | 0.010 | 0.020 | 0.00 | 0.07 | 0.18 |

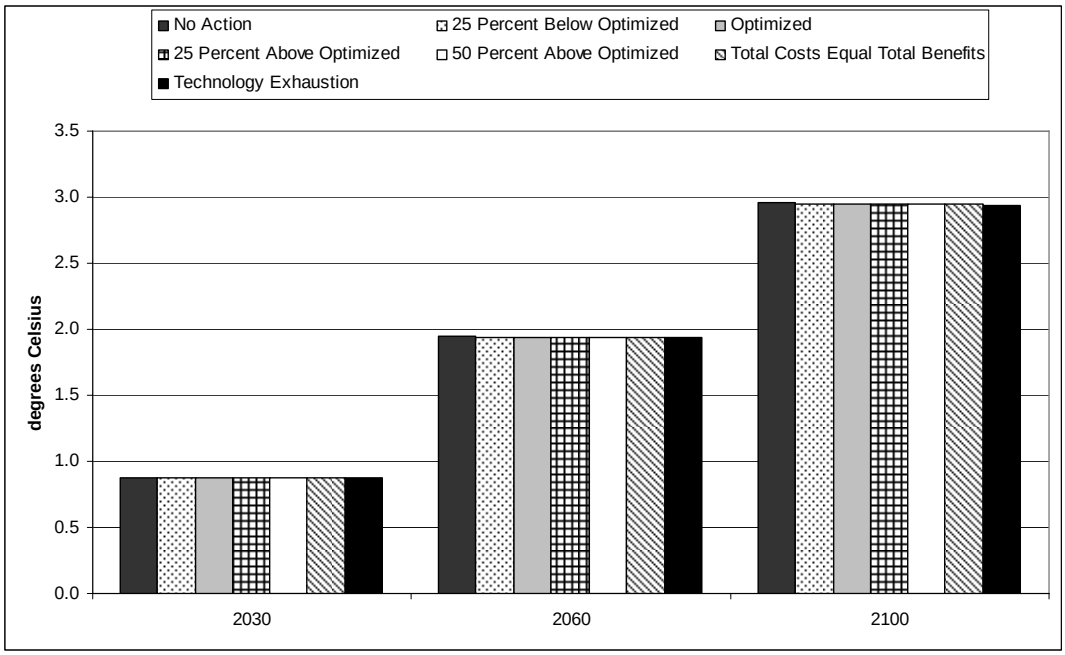
a/ The A1B scenario is the SRES marker scenario used by IPCC Working Group I to represent the SRES A1B (medium) storyline.

**Figure S-1. Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on $CO_2$ (ppm) Concentrations Using MAGICC (A1B a/)**



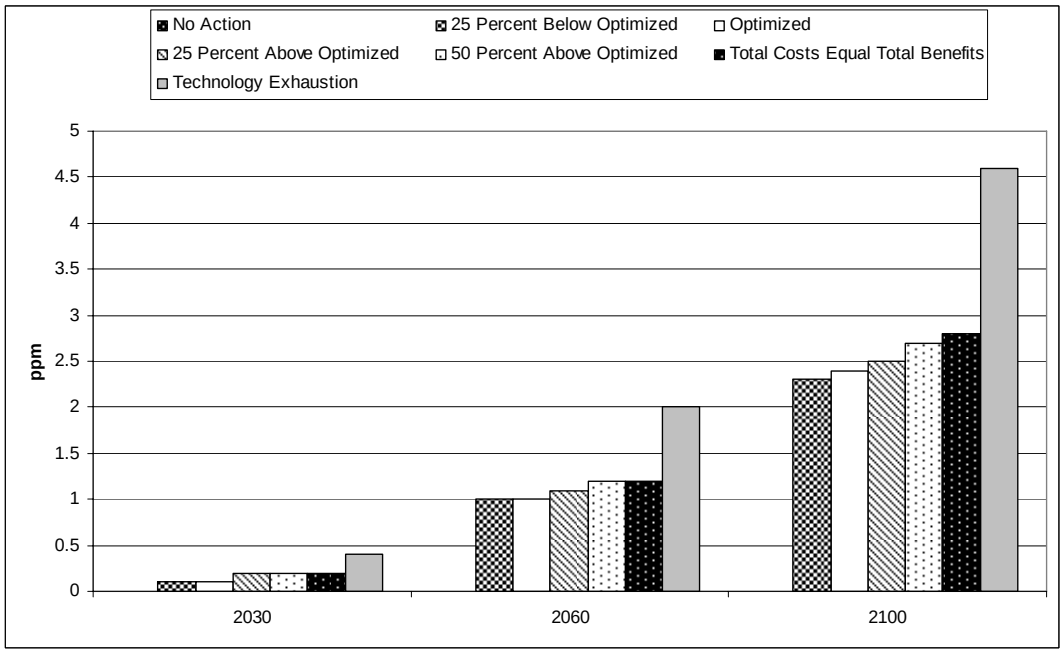

a/ The A1B scenario is the SRES marker scenario used by IPCC Working Group I to represent the SRES A1B (medium) storyline.

**Figure S-2. Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on Global Mean Surface Temperature Increase (°C) Using MAGICC (A1B a/)**



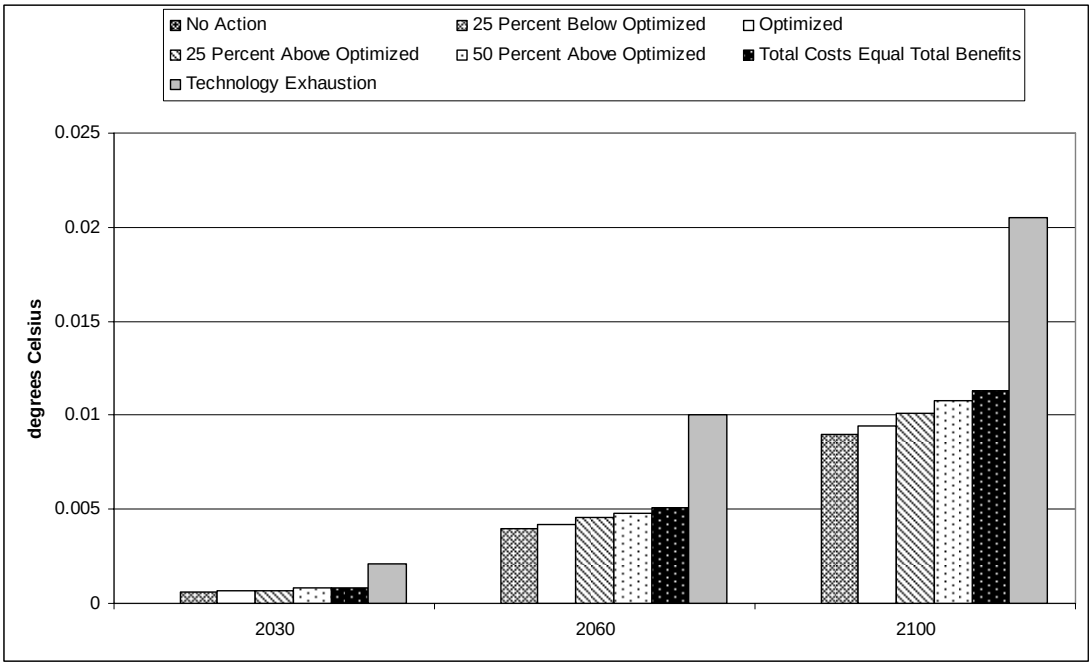

a/ The A1B scenario is the SRES marker scenario used by IPCC Working Group I to represent the SRES A1B (medium) storyline.

**Figure S-3. Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on the Reduction in the Growth of $CO_2$ Concentrations (ppm) Using MAGICC (A1B a/)**




a/ The A1B scenario is the SRES marker scenario used by IPCC Working Group I to represent the SRES A1B (medium) storyline.

**Figure S-4. Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards Cumulative Impact on the Reduction in the Growth of Global Mean Temperature (°C) Using MAGICC (A1B a/)**




a/ The A1B scenario is the SRES marker scenario used by IPCC Working Group I to represent the SRES A1B (medium) storyline.

### S.5.2.7 Climate - Reference Case Global Mean Precipitation

The action alternatives reduce temperature increases slightly compared to the No Action Alternative. Thus, the action alternatives also reduce predicted increases in precipitation slightly, as shown in Table S-19. As shown in the table, there is a fairly narrow band of mid-range estimated reductions in precipitation increase as of 2100, from 4.48 percent to 4.51 percent, and there is very little difference between the alternatives. Uncertainty in these numbers results from uncertainty in the increase in global mean surface temperature and uncertainty about the change in global mean precipitation.

### S.5.2.8 Climate - Reference Case Impact on Sea-level Rise

The IPCC Fourth Assessment Report identifies four primary components of sea-level rise: thermal expansion of ocean water; melting of glaciers and ice caps; loss of land-based ice in Antarctica; and loss of land-based ice in Greenland. Ice-sheet discharge is an additional factor that could influence sea level over the long term. The MAGICC model calculates the oceanic thermal expansion component of global mean sea-level rise, using a non-linear temperature- and pressure-dependent expansion coefficient. It also addresses the other three primary components through ice-melt models for small glaciers and the Greenland and Antarctic ice sheets, and excludes non-melt sources, which the IPCC Fourth Assessment Report also excluded.

Table S-18 lists the impact on sea-level rise associated with the Reference Case for each alternative and shows sea-level rise in 2100 ranging from 37.10 centimeters under Alternative 1 (No Action) to 36.92 centimeters under the Technology Exhaustion Alternative (Alternative 7), for a maximum reduction of 0.18 centimeters by 2100 from the CAFE alternatives.

**Table S-19**

**Reference Case MY 2011-2015 Standards and Potential MY 2016-2020 Standards**
**Cumulative Impact on Reductions in Global Mean Precipitation Based on A1B a/ SRES Scenario, Using Increases in Global Mean Surface Temperature Simulated by MAGICC**

| Scenario | 2011–2030/2020 | 2046–2065/2055 | 2080–2099/2090 |
|---|---|---|---|
| **Global Mean Precipitation Change** | | | |
| | 1.45 | 1.51 | 1.63 |
| **Global Temperature Above Average 1980-1999 Levels ($^oC$) for the A1B Scenario by 2100, Mid-level Results** | | | |
| 1 No Action | 0.560 | 1.764 | 2.765 |
| 2 25 Percent Below Optimized | 0.560 | 1.759 | 2.753 |
| 3 Optimized | 0.560 | 1.758 | 2.752 |
| 4 25 Percent Above Optimized | 0.560 | 1.758 | 2.751 |
| 5 50 Percent Above Optimized | 0.560 | 1.757 | 2.750 |
| 6 Total Costs Equal Total Benefits | 0.560 | 1.757 | 2.750 |
| 7 Technology Exhaustion | 0.559 | 1.756 | 2.749 |
| **Reduction in Global Temperature ($^oC$) for the A1B Scenario, Mid-level Results** | | | |
| 2 25 Percent Below Optimized | 0.000 | 0.005 | 0.011 |
| 3 Optimized | 0.000 | 0.006 | 0.013 |
| 4 25 Percent Above Optimized | 0.000 | 0.006 | 0.014 |
| 5 50 Percent Above Optimized | 0.000 | 0.007 | 0.015 |
| 6 Total Costs Equal Total Benefits | 0.000 | 0.007 | 0.015 |
| 7 Technology Exhaustion | 0.000 | 0.008 | 0.016 |
| **Mid-level Global Mean Precipitation Change by 2100 (%)** | | | |
| 1 No Action | 0.81 | 2.66 | 4.51 |
| 2 25 Percent Below Optimized | 0.81 | 2.66 | 4.49 |
| 3 Optimized | 0.81 | 2.65 | 4.49 |
| 4 25 Percent Above Optimized | 0.81 | 2.65 | 4.48 |
| 5 50 Percent Above Optimized | 0.81 | 2.65 | 4.48 |
| 6 Total Costs Equal Total Benefits | 0.81 | 2.65 | 4.48 |
| 7 Technology Exhaustion | 0.81 | 2.65 | 4.48 |
| **Reduction in Global Mean Precipitation (%)** | | | |
| 2 25 Percent Below Optimized | 0.00 | 0.01 | 0.02 |
| 3 Optimized | 0.00 | 0.01 | 0.02 |
| 4 25 Percent Above Optimized | 0.00 | 0.01 | 0.02 |
| 5 50 Percent Above Optimized | 0.00 | 0.01 | 0.02 |
| 6 Total Costs Equal Total Benefits | 0.00 | 0.01 | 0.02 |
| 7 Technology Exhaustion | 0.00 | 0.01 | 0.03 |

a/ The A1B scenario is the SRES marker scenario used by IPCC Working Group I to represent the SRES A1B (medium) storyline.

In summary, the impacts of the MY 2011-2020 CAFE alternatives on global mean surface temperature, sea-level rise, and precipitation are relatively small in the context of the expected changes associated with the emissions trajectories in the Special Report on Emission Scenarios (SRES). This is due primarily to the global and multi-sectoral nature of the climate problem. Emissions of $CO_2$, the primary gas driving the climate effects, from the United States passenger-car and light-truck fleet represented about 2.5 percent of total global emissions of GHGs in the year 2000.[15] While a substantial source, this is a still small percentage of global emissions, and the relative contribution of $CO_2$ emissions

[15] $CO_2$ emissions from passenger cars and light trucks were obtained from EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks. 1990–2006*, which can be found at http://www.epa.gov/climatechange/emissions/usinventoryreport.html. Global GHG emissions were obtained from the World Resources Institute's Climate Analysis Indicators Tool (CAIT) Version 5.0. http://cait.wri.org.

from the U.S. passenger car and light truck fleet is expected to decline in the future, due primarily to rapid growth of emissions from developing economies, which are due in part to growth in emissions from the global transportation sector.

### S.5.2.9 Cumulative Impacts - Input Scenarios

In response to public comments, and to test how different economic assumptions might affect estimates of cumulative emissions reductions and resulting climate effects, NHTSA modeled three additional scenarios – High, Mid-1, and Mid-2 – and compared the results to the Reference Case. Variables that were altered include fuel price, the social cost of carbon, oil import externalities, and the discount rate for other benefits. Tables S-20 and S-21 lists the results for the High Scenario.

As shown in Table S-20, compared to the Reference Case, total cumulative emissions under the High Scenario were lower for all alternatives. The primary reason for this difference is the lower vehicle miles traveled forecast under the High Scenario. Cumulative emissions reductions for Alternatives 2 through 7 compared to the No Action Alternative were all higher under the High Scenario than under the Reference Case, except the Technology Exhaustion Alternative. Emissions reductions were greater under the Technology Exhaustion Alternative for the Reference Case than for the High Scenario.

**Table S-20**

**High Scenario Alternative CAFE Standards Cumulative Emissions and Emissions Reductions Due to the MY 2011-2015 Standards and Potential MY 2016-2020 Standards for 2010 through 2100 ($MMTCO_2$)**

| Alternative | Emissions | Emissions Reductions Compared to No Action Alternative |
|---|---|---|
| 1 No Action | 195,501 | 0 |
| 2 25 Percent Below Optimized | 160,903 | 34,598 |
| 3 Optimized | 157,088 | 38,413 |
| 4 25 Percent Above Optimized | 154,618 | 40,884 |
| 5 50 Percent Above Optimized | 151,781 | 43,721 |
| 6 Total Costs Equal Total Benefits | 150,919 | 44,583 |
| 7 Technology Exhaustion | 152,290 | 43,211 |

Table S-21 shows the resulting effects on $CO_2$ concentration, global mean surface temperature, and sea-level rise. Under the High Scenario, the resulting $CO_2$ concentration, global mean surface temperature, and sea-level rise were lower for all alternatives except the Technology Exhaustion Alternative. Thus, the differences for the action alternatives compared to the No Action Alternative are greater for the High Scenario than the Reference Case, except for the Technology Exhaustion Alternative.

## S.5.3 Other Potential Environmental Consequences

While the main focus of this FEIS is on the quantification of impacts to energy, air quality, climate, and qualitative cumulative impacts resulting from climate change, this FEIS also addresses other potentially affected resources. NHTSA conducted a qualitative review of the non-climate change related direct, indirect, and cumulative effects, either positive or negative, of the alternatives on other potentially affected resources. These resource areas included water resources, biological resources, land use, hazardous materials, safety, noise, historic and cultural resources, and environmental justice. Effects of the alternatives on these resources were too small to address quantitatively. Impacts to biological resources could include reductions in habitat disturbance, decreased impacts from acid rain on water and terrestrial habitats from decreases in petroleum production and increased agricultural disturbances and

**Table S-21**

**High Scenario MY 2011-2015 Standards and Potential MY 2016-2020 Standards**
**Cumulative Impact on $CO_2$ Concentrations, Global Mean Surface Temperature Increase, and Sea-level Rise in 2100 Using MAGICC (A1B a/)**

| Totals by Alternative | $CO_2$ Concentration (ppm) | | | Global Mean Surface Temperature Increase (°C) | | | Sea-level Rise (cm) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2030 | 2060 | 2100 | 2030 | 2060 | 2100 | 2030 | 2060 | 2100 |
| 1 No Action | 455.5 | 573.7 | 717.2 | 0.874 | 1.944 | 2.959 | 7.99 | 19.30 | 37.10 |
| 2 25 Percent Below Optimized | 455.3 | 572.3 | 714.0 | 0.873 | 1.938 | 2.946 | 7.99 | 19.26 | 36.99 |
| 3 Optimized | 455.2 | 572.1 | 713.6 | 0.872 | 1.937 | 2.944 | 7.99 | 19.25 | 36.97 |
| 4 25 Percent Above Optimized | 455.2 | 572.0 | 713.4 | 0.872 | 1.937 | 2.943 | 7.99 | 19.25 | 36.96 |
| 5 50 Percent Above Optimized | 455.2 | 571.9 | 713.1 | 0.872 | 1.936 | 2.942 | 7.99 | 19.25 | 36.95 |
| 6 Total Costs Equal Total Benefits | 455.2 | 571.9 | 713.0 | 0.872 | 1.936 | 2.942 | 7.99 | 19.24 | 36.95 |
| 7 Technology Exhaustion | 455.2 | 571.9 | 713.1 | 0.872 | 1.935 | 2.941 | 7.99 | 19.24 | 36.94 |
| **Reduction under CAFE Alternatives** | | | | | | | | | |
| 2 25 Percent Below Optimized | 0.2 | 1.4 | 3.2 | 0.001 | 0.006 | 0.013 | 0.00 | 0.04 | 0.11 |
| 3 Optimized | 0.3 | 1.6 | 3.6 | 0.001 | 0.007 | 0.015 | 0.00 | 0.05 | 0.13 |
| 4 25 Percent Above Optimized | 0.3 | 1.7 | 3.8 | 0.001 | 0.007 | 0.016 | 0.00 | 0.05 | 0.14 |
| 5 50 Percent Above Optimized | 0.3 | 1.8 | 4.1 | 0.001 | 0.008 | 0.017 | 0.00 | 0.05 | 0.15 |
| 6 Total Costs Equal Total Benefits | 0.3 | 1.8 | 4.2 | 0.002 | 0.008 | 0.017 | 0.00 | 0.06 | 0.15 |
| 7 Technology Exhaustion | 0.3 | 1.8 | 4.1 | 0.002 | 0.009 | 0.018 | 0.00 | 0.06 | 0.16 |

a/ The A1B scenario is the SRES marker scenario used by the IPCC WGI to represent the SRES A1B (medium) storyline.

runoff due to biofuel production. Impacts to land use and development could include increased agricultural land use. Impacts to safety could include downweighting of vehicles and increased VMT, resulting in increased traffic injuries and fatalities. Impacts to hazardous materials could include overall reductions in the generation of air and oil production related wastes, and increases in agricultural wastes due to biofuel production. Impacts to historic and cultural resources could include reductions in acid rain related damage. Noise impacts could include increased noise levels in some areas due to higher VMT. The non-climate related impact from increased atmospheric $CO_2$ could, in conjunction with other environmental factors and changes in plant communities, potentially alter growth, abundance, and respiration rates of some soil microbes and impact coral reef and other marine ecosystems from ocean acidification.

Impacts to environmental justice populations could include increased air toxics in some areas as a result of higher VMT. No impacts are expected to resources protected under Section 4(f), and a Section 7 Review under the Endangered Species Act is not required.

### S.5.4 Mitigation Measures and Unavoidable Adverse Impacts

Each of the six action alternatives, under any Input Scenario, would result in a decrease in $CO_2$ emissions and associated climate change impacts, a general decrease in criteria air pollutant emissions and toxic air pollutant emissions, and a decrease in energy consumption as compared to the No Action Alternative. Based on our current understanding of global climate change, certain effects are likely to occur due to the sum total of GHG emissions entering the atmosphere. Any of the alternatives presented here would not prevent these effects. They may diminish the effects of climate change and contribute to global GHG reductions. Under the No Action alternative, $CO_2$ emissions and energy consumption would continue to increase; thus, any of the alternatives (other than the No Action Alternative) would have a beneficial effect that would not need mitigation.

Increases in national CO emissions could occur under the Optimized Alternative of the Reference Case. While nominally high, these increases are just 0.6 percent of the CO emissions of the No Action Alternative. Furthermore, no violations of the CO standard have been demonstrated since 2002, making any potential increase in these emissions less likely to affect human health even if they were to occur. Localized increases in criteria and toxic air pollutant emissions could occur in some non-attainment areas as a result of implementation of the CAFE standards under the alternatives. These localized increases represent a slight decline in the rate of reductions being achieved by implementation of CAA standards. The Federal Highway Administration has funds dedicated to the reduction of air pollution in nonattainment areas, providing state and local authorities the ability to mitigate for localized increases in levels of criteria and toxic air pollutants in nonattainment areas that might be observed under the standards. Further, EPA has the authority to continue to improve vehicle emissions standards.