Overview

EPA has performed an illustrative analysis of the potential costs and human health and visibility benefits of nationally attaining a new ozone standard of 0.075 ppm. Per Executive Order 12866 and the guidelines of OMB Circular A-4, this Regulatory Impact Analysis (RIA) also presents analyses of three alternative standards, a less stringent 0.079 ppm and two more stringent options (0.065 and 0.070 ppm). The benefit and cost estimates below are calculated incremental to a 2020 baseline that incorporates air quality improvements achieved through the projected implementation of existing regulations and full attainment of the existing ozone and particulate matter (PM) National Ambient Air Quality Standards (NAAQS). The baseline also includes the Clean Air Interstate Rule and mobile source programs, which will help many areas move toward attainment of the current ozone standard.

This RIA is focused on development and analyses of illustrative control strategies to meet these alternative standards in 2020. This analysis does not prejudge the attainment dates that will ultimately be assigned to individual areas under the Clean Air Act, which contains a variety of potential dates and flexibility for extensions. For purposes of this analysis, though, we assume attainment by 2020 for all areas except for two areas (San Joaquin Valley and South Coast air basins) in California. The state has submitted to EPA plans for implementing the current ozone standard which propose that these two areas of California meet that standard by 2024. We have assumed for analytical purposes that the San Joaquin Valley and South Coast air basin would attain a new standard in 2030. The actual attainment year for all areas will be determined through the State Implementation Plan process. A separate analysis for the San Joaquin Valley and South Coast air basins in California is provided in Appendix 7b.

EPA designed a two-stage approach to estimating costs and benefits, because we recognized that some areas with significant ozone problems would need emission controls beyond those currently available to meet either the 1997 ozone standards, or alternative, more stringent standards. However, as documented in Chapter 5, there are numerous examples of how technological innovation has led to the development of new and improved ways of reducing air pollution, often at lower cost than estimated at the time a new NAAQS is established. The individual chapters of the RIA present more detail regarding estimated costs and benefits based on both partial attainment (manageable with current technologies) and full attainment (which in some locations will require new or innovative approaches and technology).

In setting primary ambient air quality standards, EPA's responsibility under the law is to establish standards that protect public health. The Clean Air Act ("Act") requires EPA, for each criteria pollutant, to set a standard that protects public health with "an adequate margin of safety." As interpreted by the Agency and the courts, the Act requires EPA to base this decision on health considerations only; economic factors cannot be considered.

The prohibition against the consideration of cost in the setting of the primary air quality standards, however, does not mean that costs, benefits or other economic considerations are unimportant or should be ignored. The Agency believes that consideration of costs and benefits is an essential decision making tool for the efficient implementation of these standards. The impacts of cost, benefits, and efficiency are considered by the States when they make decisions regarding what timelines, strategies, and policies make the most sense.

Because States are ultimately responsible for implementing strategies to meet revised standards, this RIA provides insights and analysis of a limited number of illustrative control strategies that states might adopt to meet any revised standard. These illustrative strategies are subject to a number of important assumptions, uncertainties and limitations, which we document in the relevant portions of the analysis.

ES.1 Approach to the Analysis

This RIA consists of multiple analyses including an assessment of the nature and sources of ambient ozone; estimates of current and future emissions of relevant precursors that contribute to the problem; air quality analyses of baseline and alternative control strategies; development of illustrative control strategies to attain the standard alternatives in future years; estimates of the incremental costs and benefits of attaining the alternative standards, together with an examination of key uncertainties and limitations; and a series of conclusions and insights gained from the analysis.

The air quality modeling results for the *regulatory baseline* (explained in Chapter 3) provide the starting point for developing illustrative control strategies to attain the alternative standards that are the focus of this RIA. The baseline shows that by 2020, while ozone air quality would be significantly better than today under current requirements, several eastern and western states would need to develop and adopt additional controls to attain the new standard. After existing control technologies have been applied, additional unspecified emission reductions are applied to establish attainment. The cost of these unknown controls was extrapolated and is included in the total cost numbers.

In selecting controls, we focused more on ozone cost-effectiveness (measured as $/ppb) than on the NOx or VOC cost-effectiveness (measured as $/ton). Most of the overall reductions in NOx achieved our illustrative control strategy were from non-EGU point sources. The NOx based illustrative control strategies we analyzed are also expected to reduce ambient $PM_{2.5}$ levels in many locations. The total benefits estimates described here include the co-benefits of reductions in fine particulate levels (PM) associated with year-round application of NOx control strategies beyond those in the regulatory baseline. In moving further down the list of cost-effective known and available controls, we deplete our database of available choices of known controls, and are left with background emissions and remaining anthropogenic emissions for which we do not have enough knowledge to determine how, and at what cost, reductions can be achieved in the future when attainment would be required.

Estimated reductions in premature mortality from reductions in ambient ozone and PM dominate the benefits estimates. For this reason, our assessment provides a range of estimates for both PM and ozone premature mortality. Although we note that there are uncertainties that are not fully captured by this range of estimates, and that additional research is needed to more fully establish underlying mechanisms by which such effects occur, such ranges are illustrative of the extent of uncertainly associated with some different modeling assumptions.

ES.2 Results of Benefit-Cost Analysis

The following is a presentation of the benefits and costs of attaining various Ozone National Ambient Air Quality Standards in the year 2020. These estimates only include areas assumed to meet the current standard by 2020. As mentioned earlier, they do not include the costs or benefits of attaining the alternate standards in San Joaquin Valley and South Coast air basins. Due to the differences in attainment year and other assumptions underlying the 2020 analysis presented here, and the 2030 analysis in Appendix 7b, it is not appropriate to add the results together to get a national "full attainment" scenario.

In Tables ES.1 through ES.4, the individual row estimates reflect the different studies available to describe the ozone premature mortality relationship. Ranges within the total benefits column reflect variability in the studies upon which the estimates associated with premature mortality were derived. For the 0.075ppm alternative, $PM_{2.5}$ co-benefits account for between 42 and 99 percent of total benefits depending upon the study used. Details about these studies are in Chapter 6.

Ranges in the total costs column reflect different assumptions about the extrapolation of costs as discussed in Chapter 5. The low end of the range of net benefits is constructed by subtracting the highest cost from the lowest benefit, while the high end of the range is constructed by subtracting the lowest cost from the highest benefit. The presentation of the net benefit estimates represents the widest possible range from this analysis. These tables do not include visibility benefits, which are estimated at $160 million/yr.

Table ES.1: Estimated Range of Annual Monetized Costs and Ozone Benefits and $PM_{2.5}$ Co-Benefits: 0.075 ppm Standard in 2020 in Billions of 2006$*

Ozone Mortality Function or Assumption	Reference	Total Benefits** 3%	Total Benefits** 7%	Total Costs*** 7%	Net Benefits 3%	Net Benefits 7%
NMMAPS	Bell et al. 2004	2.6 – 17	2.4 – 16	7.6 – 8.8	–6.3 – 9.5	–6.4 – 7.9
Meta-analysis	Bell et al. 2005	3.8 – 18	3.6 – 17	7.6 – 8.8	–5.0 – 11	–5.2 – 9.1
	Ito et al. 2005	4.4 – 19	4.3 – 17	7.6 – 8.8	–4.4 – 11	–4.5 – 9.8
	Levy et al. 2005	4.5 – 19	4.4 – 17	7.6 – 8.8	–4.3 – 11	–4.5 – 9.9
Assumption that association is not causal****		2.0 – 17	1.8 – 15	7.6 – 8.8	–6.8 – 9	–7.0 – 7.4

Table ES.2: Estimated Range of Annual Monetized Costs and Ozone Benefits and $PM_{2.5}$ Co-Benefits: 0.079 ppm Standard in 2020 in Billions of 2006$*

Ozone Mortality Function or Assumption	Reference	Total Benefits** 3%	Total Benefits** 7%	Total Costs*** 7%	Net Benefits 3%	Net Benefits 7%
NMMAPS	Bell et al. 2004	1.4 – 11	1.3 – 9.9	2.4 – 2.9	–1.5 – 8.5	–1.6 – 7.5
Meta-analysis	Bell et al. 2005	1.9 – 11	1.8 – 10	2.4 – 2.9	–1.1 – 8.9	–1.2 – 7.9
	Ito et al. 2005	2.1 – 12	2.0 – 11	2.4 – 2.9	–0.83 – 9.2	–0.9 – 8.1
	Levy et al. 2005	2.1 – 12	2.0 – 11	2.4 – 2.9	–0.80 – 9.2	–0.9 – 8.2
Assumption that association is not causal****		1.2 – 11	1.1 – 9.7	2.4 – 2.9	–1.7 – 8.3	–1.8 – 7.3

Table ES.3: Estimated Range of Annual Monetized Costs and Ozone Benefits and $PM_{2.5}$ Co-Benefits: 0.070 ppm Standard in 2020 in Billions of 2006$*

Ozone Mortality Function or Assumption	Reference	Total Benefits** 3%	Total Benefits** 7%	Total Costs*** 7%	Net Benefits 3%	Net Benefits 7%
NMMAPS	Bell et al. 2004	5.4 – 29	5.1 – 27	19 – 25	–20 – 10	–20 – 7.6
Meta-analysis	Bell et al. 2005	9.7 – 34	9.5 – 31	19 – 25	–15 – 15	–16 – 12
	Ito et al. 2005	12 – 36	12 – 33	19 – 25	–13 – 17	–13 – 14
	Levy et al. 2005	12 – 36	12 – 33	19 – 25	–13 – 17	–13 – 14
Assumption that association is not causal****		3.5 – 27	3.2 – 25	19 – 25	–22 – 8	–22 – 5.7

Table ES.4: Estimated Range of Annual Monetized Costs and Ozone Benefits and $PM_{2.5}$ Co-Benefits: 0.065 ppm Standard in 2020 in Billions of 2006$*

Ozone Mortality Function or Assumption	Reference	Total Benefits** 3%	Total Benefits** 7%	Total Costs*** 7%	Net Benefits 3%	Net Benefits 7%
NMMAPS	Bell et al. 2004	9.0 – 46	8.6 – 42	32 – 44	–35 – 14	–35 – 9.7
Meta-analysis	Bell et al. 2005	17 – 54	16 – 50	32 – 44	–27 – 22	–28 – 18
	Ito et al. 2005	21 – 58	21 – 54	32 – 44	–23 – 26	–23 – 22
	Levy et al. 2005	21 – 58	21 – 54	32 – 44	–23 – 26	–23 – 22
Assumption that association is not causal****		5.5 – 42	5.1 – 38	32 – 44	–39 – 10	–39 – 6.2

*All estimates rounded to two significant figures. As such, they may not sum across columns. These estimates do not include visibility benefits. Only includes areas required to meet the current standard by 2020, does not include San Joaquin and South Coast areas in California. Appendix 7b shows the costs and benefits of attaining alternate standards in San Joaquin and South Coast California.

**Includes ozone benefits, and PM 2.5 co-benefits. Range was developed by adding the estimate from the ozone premature mortality function to both the lower and upper ends of the range of the PM2.5 premature mortality functions characterized in the expert elicitation. Tables exclude unquantified and nonmonetized benefits.

***Range reflects lower and upper bound cost estimates. Data for calculating costs at a 3% discount rate was not available for all sectors, and therefore total annualized costs at 3% are not presented here. Additionally, these estimates assume a particular trajectory of aggressive technological change. An alternative storyline might hypothesize a much less optimistic technological trajectory, with increased costs, or with decreased benefits in 2020 due to a later attainment date.

****Total includes ozone morbidity benefits and total PM co-benefits only.

Table ES.5 presents the total number of estimated ozone and $PM_{2.5}$-related premature mortalities and morbidities avoided nationwide in 2020.

Table ES.5: Summary of Total Number of Annual Ozone and $PM_{2.5}$-Related Premature Mortalities and Premature Morbidity Avoided: 2020 National Benefits*

Combined Estimate of Mortality Standard Alternative and Model or Assumption		Combined Range of Ozone Benefits and $PM_{2.5}$ Co-Benefits**			
		0.079 ppm	0.075 ppm	0.070 ppm	0.065 ppm
NMMAPS	Bell (2004)	140 – 1,300	260 – 2,000	560 – 3,500	940 – 5,500
Meta-Analysis	Bell (2005)	200 – 1,300	420 – 2,200	560 – 4,100	2,000 – 6,500
	Ito (2005)	230 – 1,300	500 – 2,300	1,100 – 4,300	2,500 – 7,000
	Levy (2005)	230 – 1,400	510 – 2,300	1,400 – 4,400	2,500 – 7,100
Assumption that association is not causal***		120 – 1,200	190 – 2,000	310 – 3,200	490 – 5,000
Combined Estimate of Morbidity					
Acute Myocardial Infarction		570	890	1,500	2,300
Upper Respiratory Symptoms		3,100	4,900	8,100	13,000
Lower Respiratory Symptoms		4,200	6,700	11,000	17,000
Chronic Bronchitis		240	380	630	970
Acute Bronchitis		640	1,000	1,700	2,600
Asthma Exacerbation		3,900	6,100	10,000	16,000
Work Loss Days		28,000	43,000	72,000	110,000
School Loss Days		72,000	200,000	640,000	1,100,000
Hospital and ER Visits		890	1,900	5,100	9,400
Minor Restricted Activity Days		340,000	750,000	2,100,000	3,500,000

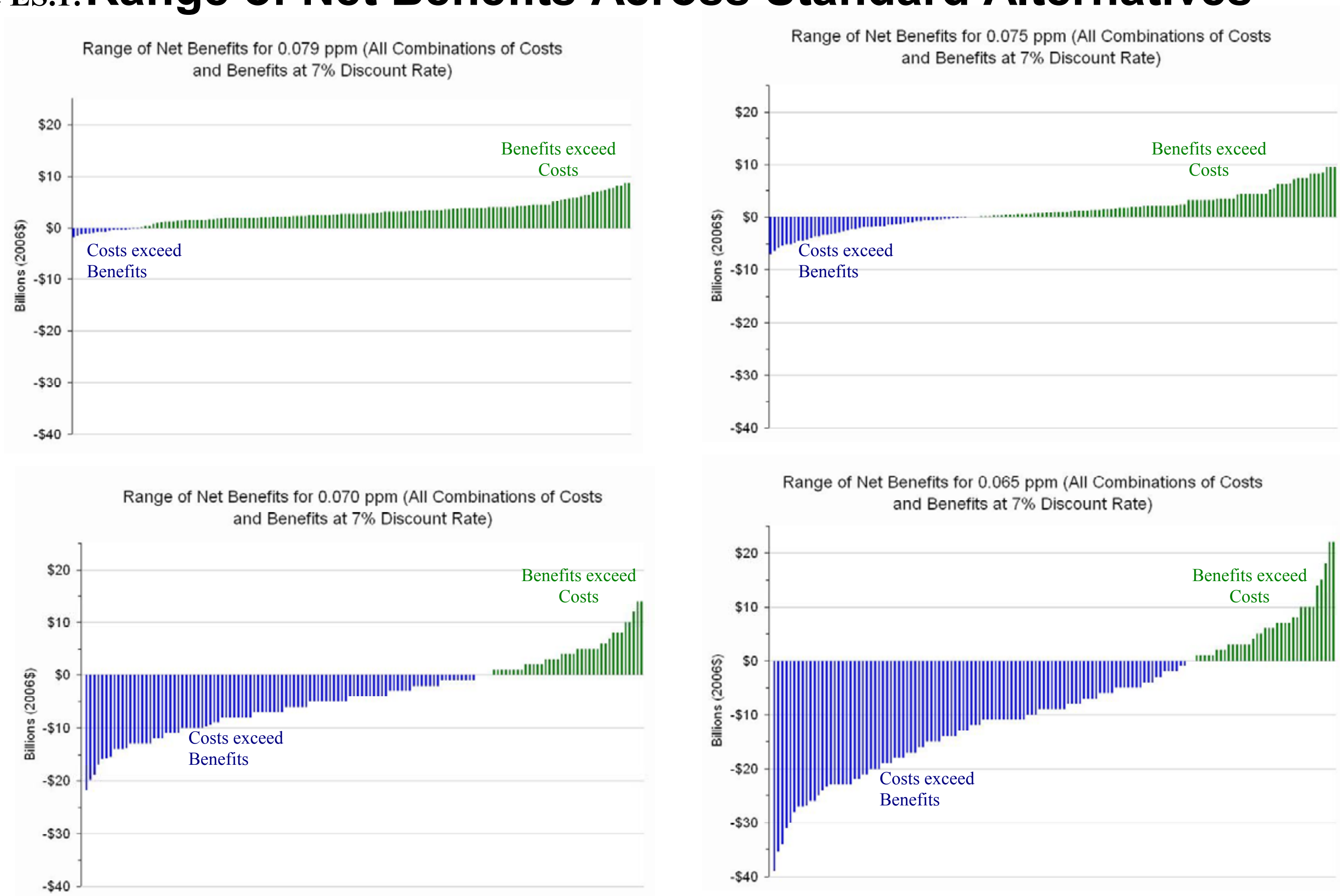
*Only includes areas required to meet the current standard by 2020, does not include San Joaquin Valley and South Coast air basins in California. Appendix 7b shows the costs and benefits of attaining alternate standards in San Joaquin and South Coast California.

**Includes ozone benefits, and PM 2.5 co-benefits. Range was developed by adding the estimate from the ozone premature mortality function to both the lower and upper ends of the range of the PM2.5 premature mortality functions characterized in the expert elicitation described in Chapter 6.

***Estimated reduction in premature mortality due to $PM_{2.5}$ reductions only

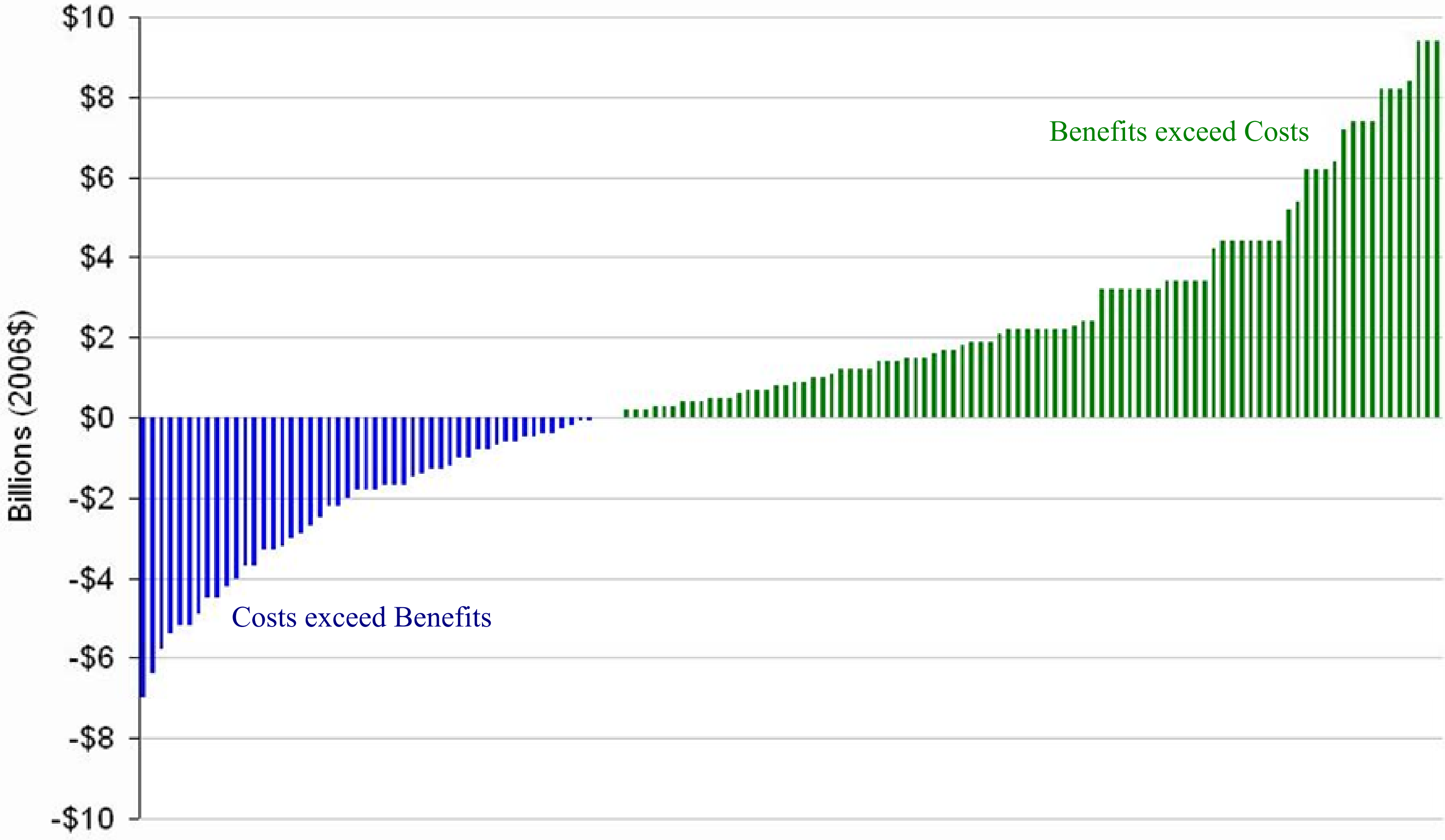
The following set of graphs is included to provide the reader with a richer presentation of the range of costs and benefits of the alternative standards. The graphs supplement the tables by displaying all possible combinations of net benefits, utilizing the five different ozone functions, the fourteen different PM functions, and the two cost methods. Each of the 140 bars in each graph represents an independent and equally probably point estimate of net benefits under a certain combination of cost and benefit estimation methods. Thus it is not possible to infer the likelihood of any single net benefit estimate. The blue bars indicate combinations where the net benefits are negative, whereas the green bars indicate combinations where net benefits are positive. Figure ES.1 shows all of these combinations for all standards analyzed. Figure ES.2 shows a close-up of the range of net benefits for the selected standard of 0.075 ppm.

Figure ES.1: **Range of Net Benefits Across Standard Alternatives***



* This graph shows all 140 combinations of the 5 different ozone mortality functions and assumptions, the 14 different PM mortality functions, and the 2 cost methods. All combinations are treated as independent and equally probable.

Figure ES.2: Range of Net Benefits for 0.075 ppm (All Combinations of Costs and Benefits at 7% Discount Rate) *



* This graph shows all 140 combinations of the 5 different ozone mortality functions and assumptions, the 14 different PM mortality functions, and the 2 cost methods. All combinations are treated as independent and equally probable.

For the selected standard of 0.075 ppm, the median value of all of the independent point estimates is $0.8 billion, and the majority (64%) of the combinations indicate positive net benefits for this standard.

ES.3 Caveats and Conclusions

Of critical importance to understanding these estimates of future costs and benefits is that they are not intended to be forecasts of the actual costs and benefits of implementing revised standards. There are many challenges in estimating the costs and benefits of attaining a tighter ozone standard, which are fully discussed in Chapters 5, 6, and 7. Analytically, the characterization of mortality benefits and the estimation of the costs to the nation of fully attaining a tighter standard will be subject to further review by EPA science advisory boards.

There are significant uncertainties in both cost and benefit estimates. Below we summarize some of the more significant sources of uncertainty.

- Benefits estimates are influenced by our ability to accurately model relationships between ozone and PM and their associated health effects (e.g., premature mortality).

- Benefits estimates are also heavily dependent upon the choice of the statistical model chosen for each health benefit.

- EPA has requested advice from the National Academy of Sciences on how best to quantify uncertainty in the relationship between ozone exposure and premature mortality within the context of quantifying benefits. We expect to receive this advice in the spring of 2008

- As shown in figure ES.1 above, there is a considerable range of costs and benefits associated with attainment of a tighter ozone standard, especially in the range of PM 2.5 benefits. EPA has plans to ask its Science Advisory Board for advice about how to best characterize the PM mortality benefits in future analyses.

- PM co-benefits are derived primarily from reductions in nitrates (associated with NOx controls). As such, these estimates are strongly influenced by the assumption that all PM components are equally toxic. Co-benefit estimates are also influenced by the extent to which a particular area chooses to use NOx controls rather than VOC controls.

- EPA employed a monitor rollback approach to estimate the benefits of attaining an alternative standard of 0.079 ppm nationwide. This approach likely understates the benefits that would occur due to implementation of actual controls because controls implemented to reduce ozone concentrations at the highest monitor would likely result in some reductions in ozone concentrations at attaining monitors down-wind (i.e., the controls would lead to concentrations below the standard in down-wind locations).

- There are several nonquantified benefits (e.g., effects of reduced ozone on forest health and agricultural crop production) and disbenefits (e.g., decreases in tropospheric ozone lead to reduced screening of UV-B rays and reduced nitrogen fertilization of forests and cropland) discussed in this analysis in Chapter 6.

- Changes in air quality as a result of controls are not expected to be uniform over the country. In our hypothetical control scenario some increases in ozone levels occur in areas already in attainment, though not enough to push the areas into nonattainment

- As explained in Chapter 5, there are several uncertainties in our cost estimates. For example, the states are likely to use different approaches for reducing NOx and VOCs in their state implementation plans to reach a tighter standard. In addition, since our modeling of known controls does not get all areas into attainment, we needed to make assumptions about the costs of control technologies that might be developed in the future and used to meet the tighter alternative. For the 21 counties (in four geographic areas) that are not expected to attain 0.075 ppm[1] in 2020[2], assumed costs of unspecified controls represent a substantial fraction, of the costs estimated in this analysis ranging from 50% to 89% of total costs depending on the standard being analyzed.

- As discussed in Chapter 5, recent advice from EPA's Science Advisory Board has questioned the appropriateness of an approach similar to one of those used here for estimating extrapolated costs. For balance, EPA also applied a methodology recommended by the Science Advisory Board in an effort to best approximate the costs of control technologies that might be developed in the future.

- Both extrapolated costs and benefits have additional uncertainty relative to modeled costs and benefits. The extrapolated costs and benefits will only be realized to the extent that unknown extrapolated controls are economically feasible and are implemented. Technological advances over time will tend to increase the economic feasibility of reducing emissions, and will tend to reduce the costs of reducing emissions. Our estimates of costs of attainment in 2020 assume a particular trajectory of aggressive technological change. This trajectory leads to a particular level of emissions reductions and costs which we have estimated based on two different approaches, the fixed cost and hybrid approaches. An alternative storyline might hypothesize a much less optimistic technological change path, such that emissions reductions technologies for industrial sources would be more expensive or would be unavailable, so that emissions reductions from many smaller sources might be required for 2020 attainment, at a potentially greater cost per ton. Under this alternative storyline, two outcomes are hypothetically possible: Under one scenario, total costs associated with full attainment might be substantially higher. Under the second scenario, states may choose to take advantage of flexibility in the Clean Air Act to

[1] Areas that do not meet 0.075 ppm are Chicago, Houston, the Northeastern Corridor, and Sacramento. For more information see chapter 4 section 4.1.1.
[2] This list of areas does not include the San Joaquin and South Coast air basins who are not expected to attain the current 0.08 ppm standard until 2024.

adopt plan with later attainment dates to allow for additional technologies to be developed and for existing programs like EPA's Onroad Diesel, Nonroad Diesel, and Locomotive and Marine rules to be fully implemented. If states were to submit plans with attainment dates beyond our 2020 analysis year, benefits would clearly be lower than we have estimated under our analytical storyline. However, in this case, state decision makers seeking to maximize economic efficiency would not impose costs, including potential opportunity costs of not meeting their attainment date, when they exceed the expected health benefits that states would realize from meeting their modeled 2020 attainment date. In this case, upper bound costs are difficult to estimate because we do not have an estimate of the point where marginal costs are equal to marginal benefits plus the costs of nonattainment. Clearly, the second stage analysis is a highly speculative exercise, because it is based on estimating emission reductions and air quality improvements without any information about the specific controls that would be available to do so.

- This analysis shows the costs and benefits of a standard of 0.075 ppm and other alternate standards of 0.079, 0.070, and 0.065. The costs and benefits are incremental to a baseline that assumes some additional technology changes in the onroad technology sector. If these changes do not occur, then cost for all standards would increase by $1.8 billion and benefits for all standards would increase by $360 million to $3.1 billion using 2006$ and a 3% discount rate, and $330 million to $2.8 billion when using a 7% discount rate.[3] Details about costs and benefits using an alternate baseline can be found in Appendix 7a.

[3] These estimates are highly uncertain and are purely illustrative estimates of the potential costs and benefits of these mobile control strategies. We present them only as screening-level estimates to provide a bounding estimate of the costs and benefits of including these emissions controls in the ozone NAAQS control case for all standards. As such, it would be inappropriate to apply these benefit per-ton estimates to other policy contexts, including other regulatory impact analyses. Furthermore, the benefits only reflect a partial accounting of the total benefits associated with emission reductions related to the mobile controls included in this sensitivity analysis.