ES.1 Overview

This Regulatory Impact Analysis (RIA) provides illustrative estimates of the incremental costs and monetized human health benefits of attaining a lower-bound revised short-term Nitrogen Dioxide (NO_2) National Ambient Air Quality Standard (NAAQS) within the current community-wide monitoring network of 409 monitors. Because this analysis only considers counties with NO_2 monitors, the possibility exists that there may be many more potential nonattainment areas than have been analyzed in this RIA.

The proposal would set a new short-term NO_2 standard based on the 3-year average of the 99th percentile of 1-hour daily maximum concentrations, establishing a new standard within the range of 80 to 100 ppb. The proposal also requests comment on standard levels ranging from a low of 65 ppb to a high of 150 ppb. As a lower bound, we chose an alternative primary standard of 50 parts per billion (ppb) for the area-wide analysis. This more stringent NAAQS alternative affects the largest number of geographic areas that may be affected by a new NO_2 standard. Our analysis of this hypothetical scenario is meant to approximate the most comprehensive set of control strategies that areas across the country might employ to attain. (We chose 50 ppb as an analytic lower bound before decisions were made about either the proposed range, or the range for requesting public comment.) For the near-roadway analysis, we analyzed standard levels at 65 ppb, 80 ppb, 100 ppb, and 125 ppb.

It is important to reiterate that this analysis does not attempt to estimate attainment or nonattainment for any areas of the country other than those counties currently served by one of the 409 monitors in the current network. Chapter 2 explains that the current network is focused on community-wide ambient levels of NO_2, and not near-roadway levels, which may be significantly higher, and the proposal also contains requirements for an NO_2 monitoring network that would include monitors near major roadways. We recognize that once a network of near-roadway monitors is put in place, more areas could find themselves exceeding the new hourly NO_2 NAAQS. However for this RIA analysis, we lack sufficient data to predict which additional counties might exceed the new NAAQS after implementation of a near-roadway monitoring network if they do not currently have a monitor. (Regional scale models such as CMAQ do not provide a sufficient level of sub-grid detail to estimate near-road concentrations, and local-scale models such as AERMOD cannot model large regions with appropriate characterization of the near-road component of ambient air quality).

In this RIA, we projected current area-wide monitor values to future year monitor values directly, using future year CMAQ modeling outputs that take into account expected changes in emissions from 2006 to 2020. Because a near-roadway monitoring network does not currently exist, it was not possible to do this same direct projection into the future for near-roadway peaks. Because short-term peak exposures may occur near roadways, we conducted additional analysis to approximate such peak exposures. This analysis relies on current and future estimated air quality concentrations at area-wide monitors, making adjustments to future year projections using derived estimates of the relationship between future year area-wide air quality peaks and current near-roadway peaks. This additional analysis that effectively extrapolates future year near-roadway air quality from projected area-wide concentrations, contained in chapter 7, represents a screening level approximation with significant additional uncertainties.

This RIA chiefly serves two purposes. First, it provides the public with an estimate of the expected costs and benefits of attaining a new NO_2 NAAQS. Second, it fulfills the requirements of Executive Order 12866 and the guidelines of OMB Circular A-4. [1] These documents present guidelines for EPA to assess the benefits and costs of the selected regulatory option, as well as one less stringent and one more stringent option. As stated above, we chose 50 ppb as an analytic lower bound. Our original intent had been to also analyze a target NAAQS level of 100 ppb as a mid-range target identified in the Risk and Exposure Assessment (REA) as an epidemiological level of concern. We had also intended to analyze an upper bound of 200 ppb. As it turned out, as shown in chapter 3, our projections indicated no counties in the analysis year of 2020 that would have ambient 1-hour peak levels as high as the 80 to 100 ppb proposal range, assuming a baseline of no additional control beyond the controls expected from rules that are already in place (including the current $PM_{2.5}$ and ozone NAAQS).[2] Therefore the bulk of our analysis in this RIA focuses on the lower bound target NAAQS level of 50 ppb.

In setting primary ambient air quality standards, EPA's responsibility under the law is to establish standards that protect public health, regardless of the costs of implementing a new standard. The Clean Air 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 create standards based on health considerations only.

The prohibition against the consideration of cost in the setting of the primary air quality standard, however, does not mean that costs or other economic considerations are unimportant or should be ignored. The Agency believes that consideration of costs and benefits

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[1] U.S. Office of Management and Budget. Circular A-4, September 17, 2003. Available at http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf.

[2] For this RIA, we chose an analysis year of 2020. Although the actual attainment year is likely to be 2017, time and resource limitations dictated use of pre-existing model runs, which all focused on 2020. In addition, we do not have emission inventory projections for 2017; such projections are done for 5-year intervals.

is essential to making efficient, cost effective decisions for implementation of these standards. The impacts of cost and efficiency are considered by states during this process, as they decide what timelines, strategies, and policies are most appropriate. This RIA is intended to inform the public about the potential costs and benefits associated with a hypothetical scenario that may result when a new NO_2 standard is implemented, but is not relevant to establishing the standards themselves.

ES.2 Summary of Analytic Approach for the Area-wide Analysis

Our assessment of the lower bound NO_2 target NAAQS includes several key elements, including specification of baseline NO_2 emissions and concentrations; development of illustrative control strategies to attain the standard in 2020; and analyses of the control costs and health benefits of reaching the 50 ppb lower bound alternative. Additional information on the methods employed by the Agency for this RIA is presented below.

Overview of Baseline Emissions Forecast and Baseline NO_2 Concentrations

The baseline emissions and concentrations for this RIA are based on NOx emissions data from the 2002 National Emissions Inventory (NEI), and baseline NO_2 concentration values from 2005-2007 across the community-wide monitoring network. We used results from the community multi-scale air quality model (CMAQ) simulations from the ozone NAAQS RIA to calculate the expected reduction in ambient NO_2 concentrations between the 2002 base year and 2020. More specifically, design values (i.e. air quality concentrations at each monitor) were calculated for 2020 using monitored air quality concentrations from 2002 and modeled air quality projections for 2020, countywide emissions inventory data for 2002 and 2005-7, and emissions inventory projections for 2020. These data were used to create ratios between emissions and air quality, and those ratios (relative response factors, or RRFs) were used to estimate air quality monitor design values for 2020. The 2020 baseline air quality estimates revealed that ten monitors in six counties were projected to exceed a 50 ppb lower bound target NAAQS in 2020.

Development of Illustrative Control Strategies

For the lower bound of 50 ppb, we analyzed the impact that additional emissions controls applied to numerous sectors would have on predicted ambient NO_2 concentrations, incremental to the baseline set of controls. Thus the modeled analysis for a revised standard focuses specifically on incremental improvements beyond the current standards, and uses control options that might be available to states for application by 2020. The hypothetical modeled control strategy presented in this RIA is one illustrative option for achieving emissions reductions to move towards a national attainment of a tighter standard. It is not a recommendation for how a tighter NO_2 standard should be implemented, and states will make all final decisions regarding implementation strategies once a final NAAQS has been set.

Generally, we expect that the nation would be able to attain some of the tighter NO_2 NAAQS without the addition of new controls beyond those already being planned for the attainment of existing $PM_{2.5}$ and ozone standards by the year 2020. As States develop their plans for attaining these existing standards, they are likely to consider adding controls to reduce NOx, as NOx is a precursor to both $PM_{2.5}$ and ozone. These controls will also directly help areas meet a tighter NO_2 standard.

The 2020 baseline air quality estimates revealed that 10 monitors in 6 counties had projected design values exceeding 50 ppb at area monitors. We then developed a hypothetical control strategy that could be adopted to bring the current highest emitting monitor in each of those six counties into attainment with a primary standard of 50 ppb by 2020. Controls for five emissions sectors were included in the control analysis: non-electricity generating unit point sources (nonEGU), non-point area sources (area), onroad mobile sources (onroad), and nonroad mobile sources (nonroad) and electricity generating unit point sources (EGU). Finally, we note that because it was not possible, in this analysis, to bring all areas into attainment with the alternative standard of 50 ppb in all areas using only identified controls. For two monitor areas we estimated the cost of unspecified emission reductions. In chapter 4 we discuss these areas in more detail.

Analysis of Benefits

Our analysis of the benefits associated with the 50 ppb target includes benefits related to reducing NO_2 concentrations, and the ancillary benefits of reducing concentrations of particulate matter (PM). For the benefits analysis, we use the Environmental Benefits Mapping and Analysis Program (BenMAP) to estimate the health benefits occurring as a result of implementing alternative NO_2 NAAQS levels. Although BenMAP has been used extensively in previous RIAs to estimate the health benefits of reducing exposure to $PM_{2.5}$ and ozone, this is the first RIA to use BenMAP to estimate the health benefits of reducing exposure to NO_2.

The primary input to the benefits assessment is the estimated changes in ambient air quality expected to result from a simulated control strategy or attainment of a particular standard. CMAQ projects both design values at NO_2 monitors and air quality concentrations at 12km grid cells. To estimate the benefits of fully attaining the standards in all areas, EPA employed the “monitor rollback” approach to approximate the air quality change resulting from just attaining alternative NO_2 NAAQS at each design value monitor. This approach relies on data from the existing NO_2 monitoring network and the VNA interpolation method (inverse distance squared) to adjust the CMAQ-modeled NO_2 concentrations such that each areas area just attains the 50 ppb standard alternative.

We then selected health endpoints to be consistent with the conclusions of the Integrated Science Assessment (ISA) for NO_2 . In this analysis, we only estimated the benefits for those endpoints with sufficient evidence to support a quantified concentration-response relationship using the information presented in the NO_2 ISA, which contains an extensive literature review for several health endpoints related to NO_2 exposure. Based on our review of this information, we quantified three short-term morbidity endpoints that the NO_2 ISA identified as “sufficient to infer a likely causal relationship”: asthma exacerbation, respiratory-related emergency department visits, and respiratory-related hospitalizations. After identifying the health endpoints to quantify in this analysis, we then selected concentration-response functions and valuation functions based on criteria detailed in chapter 5. The valuation functions, ambient concentrations, and population data in the monitor areas are combined in BenMAP to provide the benefits estimates for this analysis.

In addition, because NO_x is also a precursor to $PM_{2.5,}$ reducing NO_x emissions in the projected non-attainment areas will also reduce $PM_{2.5}$ formation, human exposure, and the incidence of $PM_{2.5}$-related health effects. In this analysis, we estimated the co-benefits of reducing $PM_{2.5}$ exposure for the alternative standards. Due to analytical limitations, it was not possible to provide a comprehensive estimate of $PM_{2.5}$-related benefits. Instead, we used the “benefit-per-ton” method to estimate these benefits. The $PM_{2.5}$ benefit-per-ton estimates provide the total monetized human health benefits (the sum of premature mortality and premature morbidity) of reducing one ton of $PM_{2.5}$ from a specified source. EPA has used a similar technique in previous RIAs, including the recent Ozone NAAQS RIA (U.S. EPA, 2008a) and Portland Cement NESHAP RIA (U.S. EPA, 2009).

The total benefits estimates include NO_2-related benefits as well as $PM_{2.5}$ co-benefits. The two estimates use the unadjusted effect estimates (no-threshold) from two epidemiology studies examining the relationship between $PM_{2.5}$ and premature mortality using large population cohorts: the American Cancer Society cohort (Pope et al., 2002) and the Harvard Six Cities cohort (Laden et al., 2006). These estimates reflect EPA’s most current interpretation of the scientific literature on $PM_{2.5}$ and mortality, including our updated benefits methodology (i.e., a no-threshold model that calculates incremental benefits down to the lowest modeled $PM_{2.5}$ air quality levels and incorporates two technical updates) compared to the estimates in previous RIAs that did not include these changes. Table ES.4 identifies the incidences of reduced health effects expected as a result this rule from reductions in exposure to NO_2 and $PM_{2.5}$.

Analysis of Costs

Consistent with our development of the illustrative control strategies described above, our analysis of the costs associated with the 50 ppb lower bound alternative NAAQS focuses on NOx emission controls for nonEGU , area, EGU, and mobile sources.

NonEGU and area source controls largely include measures from the AirControlNET control technology database. For these sources, we estimated costs based on the cost equations included in AirControlNET. The identified controls strategy for nonEGU Point and Area sources incorporated annualized engineering cost per ton caps. These caps were defined as the upper cost per ton for controls of nonEGU point and area sources. The caps used were originally developed for the Ozone NAAQS analysis, where NOx controls were also applied. The number of applied control measures was much larger for that analysis, and therefore provides a more robust estimate of what a potential cap on NOx costs would look like.

The EGU analysis included in this RIA utilizes the latest version of the integrated planning model (IPM) v3.0 as part of the updated modeling platform.[1] IPM v3.0 includes input and model assumption updates in modeling the power sector and incorporates Federal and State rules and regulations adopted before September 2006 and various new source review (NSR) settlements. The NOx control technology options used in IPM v3.0 include Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR) systems. It is important to note that beyond these emission control options, IPM offers other compliance options for meeting emission limits. These include fuel switching, re-powering, and adjustments in the dispatching of electric generating units.

For onroad and nonroad mobile sources, costs, in terms of dollars per ton emissions reduced, were applied to emission reductions calculated for the onroad and nonroad mobile sectors that were generated using the National Mobile Inventory Model (NMIM). NMIM is an EPA model for estimating air emissions from highway vehicles and nonroad mobile equipment. NMIM uses current versions of EPA’s model for onroad mobile sources, MOBILE6, and nonroad mobile sources, NONROAD, to calculate emission inventories.[2]

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[1] http://www.epa.gov/airmarkets/progsregs/epa-ipm/past-modeling.html.

[2] More information regarding the National Mobile Inventory Model (NMIM) can be found at http://www.epa.gov/otaq/nmim.htm

Finally, as indicated in the above discussion on illustrative control strategies, implementation of the NOx control measures identified from AirControlNET and other sources does not result in attainment with the selected NAAQS in several areas. In these areas, additional unspecified emission reductions might be necessary to reach a 50 ppb target. In order to bring these monitor areas into attainment, we calculated controls costs using a fixed cost per ton approach similar to that used in the ozone RIA analysis.

ES.3 Results of 50 ppb Area-wide Analysis

Air Quality

Table ES.1. shows the projected ambient NO_2 concentrations for 2020 after application of identified controls for the area-wide analysis. It also shows the additional tons of emission reduction needed from unidentified controls to reach 50 ppb.

Table ES.1. Identified Controls Emission Reductions and Ambient Concentrations in 2020.

State	County	NOx Emission Reductions in 2020 (tons/year)	Design Values Post Application of Identified Controls (99th percentile 1-hr daily max ppb)	NOx Emission Reductions Needed Beyond Identified Controls (tons/year)
CA	**Los Angeles**	**--**	**52.5**	**18,000**
CO	**Adams**	**8,400**	**48.0**	
LA	**East Baton Rouge**	**5,300**	**50.2**	
TX	**El Paso**	**4,400**	**59.6**	**5,600**
UT	**Salt Lake**	**2,600**	**50.3**	
VA	**Charles City**	**47**	**47.9**	

Benefit and Cost Estimates

Tables ES.2 and ES.3 presents total national estimates of costs and benefits for the area-wide analysis at a 3% discount rate and a 7% discount rate.

Table ES.2: Summary of Total Costs for Alternative Standard 50 ppb in 2020 (Millions of 2006$)[a, b]

		3% Discount Rate[c]	7% Discount Rate
Identified Control Costs		$36	$44
Monitoring Costs		$7.1	$7.1
Extrapolated Costs	Fixed Cost ($10,000/ton)	$240	$240
	Fixed Cost ($15,000/ton)	$350	$350
	Fixed Cost ($20,000/ton)	$470	$470
Total Costs	Fixed Cost ($10,000/ton)	$270	$280
	Fixed Cost ($15,000/ton)	**$390**	**$400**
	Fixed Cost ($20,000/ton)	$510	$510

[a] All estimates rounded to two significant figures. As such, totals will not sum down columns.

[b] All estimates provided reflect the engineering cost of the identified control strategy analysis, incremental to a 2020 baseline of compliance with the current PM2.5 and Ozone standards.

[c] Total annualized costs were calculated using a 3% discount rate for controls which had a capital component and where equipment life values were available. For the identified control strategy, data for calculating annualized costs at a 3% discount was available for point sources. Therefore, the total annualized identified control cost value presented in this referenced cell is an aggregation of engineering costs at 3% and 7% discount rate.

Table ES.3. Summary of Total Monetized Benefits in 2020 to attain 50ppb (millions of 2006$)

	3% Full Attainment	7% Full Attainment	3% Partial Attainment	7% Partial Attainment
NO_2	\$6.3	\$6.3	\$4.6	\$4.6
$PM_{2.5}$				
Pope et al	\$270	\$240	\$140	\$130
Laden et al	\$650	\$590	\$350	\$320
TOTAL with Pope	**\$270**	**\$250**	**\$150**	**\$140**
TOTAL with Laden	**\$660**	**\$600**	**\$360**	**\$320**

*All estimates are for the analysis year (2020) and are rounded to two significant figures. These benefits estimates do not include several important benefits categories, including NO2-related premature mortality, ecosystem effects from nitrogen deposition, ozone-related health effects, or improvements in visibility.

Table ES.4: Summary of Reductions in Health Incidences from NO_2 and $PM_{2.5}$ to attain 50 ppb*

Avoided Premature Mortality	
Pope	30
Laden	80
Woodruff (Infant Mortality)	< 1
Avoided Morbidity	
Chronic Bronchitis	20
Acute Myocardial Infarction	50
Hospital Admissions, Respiratory	60
Hospital Admissions, Cardiovascular	20
Emergency Room Visits, Respiratory	220
Acute Bronchitis	4,300
Work Loss Days	590
Asthma Exacerbation	86,000
Acute Respiratory Symptoms	53,000
Lower Respiratory Symptoms	640
Upper Respiratory Symptoms	490

*All estimates are for the analysis year (2020) and are rounded to two significant figures.

The net benefits were calculated by subtracting the total cost estimate from the two estimates of total benefits. Table ES.5 shows net benefits of the selected NAAQS and alternative standards. No areas are projected to exceed 80 ppb in the area-wide analysis.

Table ES.5 Summary of Net Benefits for Alternative Standard 50 ppb in 2020 (Millions of 2006$)

	3% Discount Rate	7% Discount Rate
Total RIA Costs + Monitoring Costs	$390 + $3.6	$400 + $3.6
Total Benefits [a]	$270 - $660	$250 - $600
Total	**$(120) - $270**	**$(150) - $200**

[a] These benefits estimates do not include several important benefits categories, including NO_2-related premature mortality, ecosystem effects from nitrogen deposition, ozone-related health effects, or improvements in visibility.

ES.4. Screening-Level Analysis of Approximated Future Near-Roadway NO_2 Exceedances of Target NAAQS

Because a near-roadway monitoring network does not currently exist, it was not possible to do the same direct projection into the future for near-roadway peaks as was done for the area-wide analysis. Therefore, the near-roadway analysis represents a much more uncertain screening level approximation of future year near-roadway air quality. We first select "area-wide" monitors to adjust to approximate near-roadway conditions. The monitors included in this analysis are those considered to be representative of "area-wide" conditions; i.e. those monitors to which it would be appropriate to apply the gradient to scale from area-wide to near-roadway conditions. To reflect the expected roadway gradient discussed in the proposal preamble (i.e., near road monitors can be between 30% to 100% greater than the area wide monitors), we adjust our estimated design values at area-wide locations for the future year of 2020 by 130%, 165%, and 200%.For the near-roadway analysis, we analyzed standard levels at 65 ppb, 80 ppb, 100 ppb, and 125 ppb. We used two analytic methods to determine the 2020 design values and the tons needed to attain the various alternate standard levels: a near roadway gradient adjustment, referred to as Method 1, and a near roadway gradient adjustment with a modification to future CMAQ air quality levels, referred to as Method 2. While the modification is conceptually sound, it is a relatively new methodology. We present the results using both analytic methods.

Because this analysis examines emissions and air quality approximating near-roadway conditions, we applied controls on mobile sources. We have estimated that the annualized average cost of controls to attain the NO_2 NAAQS would be in the range of $3,000 to $6,000 per ton. This estimate is based upon previous estimates of controls for mobile sources. To calculate the near-roadway benefits, we only calculated the $PM_{2.5}$ co-benefits because it would be difficult to estimate NO_2 benefits based on the data available for this analysis, and the area-wide analysis for 50 ppb showed that the monetized NO_2 benefits only accounted for 2% of the total monetized benefits. To calculate the $PM_{2.5}$ co-benefits, we used a benefit-per-ton approach, using the benefit-per-ton estimate corresponding to NO_X emission reductions from the mobile sector. These estimates reflect EPA's most current interpretation of the scientific literature on $PM_{2.5}$ and mortality, including our updated benefits methodology (i.e., a no-threshold model that calculates incremental benefits down to the lowest modeled $PM_{2.5}$ air quality levels and incorporates two technical updates) compared to the estimates in previous RIAs that did not include these changes.

ES.5. Results from Screening Level Near-Roadway Analysis

Tables ES.6 and ES.7 show the cost and benefit results of the near-roadway analysis using the two analytic methods at discount rates of 3% and 7% respectively. The net benefits were calculated by subtracting the total cost estimate from the two estimates of total benefits. The proposed standard range of 80ppb to 100 ppb is highlighted.

Table ES.6: Benefit Cost Comparison for Near Roadway Analysis (in millions of 2006$ at a 3% discount rate for Benefits only)[a]

			Standard Level	Total Costs[b, c]			Total Benefits[d, e]			Net Benefits		
Near Roadway Analysis	Method 1	30% Gradient	65 ppb	$170	to	$330	$290	to	$700	-$40	to	$530
			80 ppb	$12	to	$20	$14	to	$34	-$6.0	to	$22
			100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
		65% Gradient	65 ppb	$1,000	to	$2,100	$1,800	to	$4,400	-$300	to	$3,400
			80 ppb	$300	to	$600	$520	to	$1,300	-$80	to	$1,000
			100 ppb	$17	to	$30	$23	to	$56	-$7.0	to	$39
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
		100% Gradient	65 ppb	$2,400	to	$4,800	$4,200	to	$10,000	-$600	to	$7,600
			80 ppb	$1,200	to	$2,300	$2,000	to	$5,000	-$300	to	$3,800
			100 ppb	$270	to	$530	$460	to	$1,100	-$70	to	$830
			125 ppb	$14	to	$24	$18	to	$43	-$6.0	to	$29
	Method 2	30% Gradient	65 ppb	$12	to	$21	$15	to	$36	-$6.0	to	$24
			80 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
			100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
		65% Gradient	65 ppb	$260	to	$510	$440	to	$1,100	-$70	to	$840
			80 ppb	$23	to	$42	$33	to	$81	-$9.0	to	$58
			100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
		100% Gradient	65 ppb	$910	to	$1,800	$1,600	to	$3,800	-$200	to	$2,900
			80 ppb	$280	to	$560	$480	to	$1,200	-$80	to	$920
			100 ppb	$17	to	$31	$24	to	$59	-$7.0	to	$42
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6

[a] All estimates are for the analysis year (2020) and are rounded to two significant figures.

[b] Costs are estimated at a 3% discount rate in the Area-wide analysis for sources where there is a capital component and O&M component.

[c] Total Cost estimates for Near roadway analysis are shown as a range of annualized costs from $3,000/ton to $6,000/ton. Results include monitoring costs of $3.6m. Costs estimates were only available for a 3% discount rate.

[d] These benefits estimates for do not include several important benefits categories, including NO_2-related premature mortality, ecosystem effects from nitrogen deposition, ozone-related health effects, or improvements in visibility.

[e] Total Benefit estimates for the Near-roadway analysis are actually $PM_{2.5}$ co-benefits, shown as a range from Pope et al to Laden et al, at a 7% discount rate, using no-threshold functions, assuming NOx emission reductions from the mobile sector.

Table ES.7: Benefit Cost Comparison for Near Roadway Analysis (in millions of 2006$ at a 7% discount rate for Benefits only)[a]

			Standard Level	Total Costs[b]			Total Benefits[c, d]			Net Benefits		
Near Roadway Analysis	**Method 1**	30% Gradient	65 ppb	$170	to	$330	$230	to	$550	-$100	to	$380
			80 ppb	$12	to	$20	$11	to	$27	-$9.0	to	$15
			100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
		65% Gradient	65 ppb	$1,000	to	$2,100	$1,400	to	$3,400	-$700	to	$2,400
			80 ppb	$300	to	$600	$410	to	$1,000	-$190	to	$700
			100 ppb	$17	to	$30	$18	to	$44	-$12	to	$27
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
		100% Gradient	65 ppb	$2,400	to	$4,800	$3,300	to	$8,100	-$1,500	to	$5,700
			80 ppb	$1,200	to	$2,300	$1,600	to	$3,900	-$700	to	$2,700
			100 ppb	$270	to	$530	$360	to	$880	-$170	to	$610
			125 ppb	$14	to	$24	$14	to	$34	-$10	to	$20
	Method 2	30% Gradient	65 ppb	$12	to	$21	$12	to	$29	-$9.0	to	$17
			80 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
			100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
		65% Gradient	65 ppb	$260	to	$510	$350	to	$850	-$160	to	$590
			80 ppb	$23	to	$42	$26	to	$64	-$16	to	$41
			100 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6
		100% Gradient	65 ppb	$910	to	$1,800	$1,300	to	$3,000	-$500	to	$2,100
			80 ppb	$280	to	$560	$380	to	$930	-$180	to	$650
			100 ppb	$17	to	$31	$19	to	$46	-$12	to	$29
			125 ppb	$3.6	to	$3.6	$0	to	$0	-$3.6	to	-$3.6

[a] All estimates are for the analysis year (2020) and are rounded to two significant figures.

[b] Total Cost estimates for Near roadway analysis are shown as a range of annualized costs from $3,000/ton to $6,000/ton. Results include monitoring costs of $3.6m. Costs estimates were only available for a 3% discount rate.

[c] These benefits estimates for the Area-wide analysis do not include several important benefits categories, including NO_2-related premature mortality, ecosystem effects from nitrogen deposition, ozone-related health effects, or improvements in visibility.

[d] Total Benefit estimates for the Near-roadway analysis are actually $PM_{2.5}$ co-benefits, shown as a range from Pope et al to Laden et al, at a 7% discount rate, using no-threshold functions, assuming NOx emission reductions from the mobile sector.

ES.6. Caveats and Limitations

Air Quality Data, Modeling and Emissions

- Current $PM_{2.5}$ and Ozone Controls in Baseline: Our 2020 analysis year baseline assumes that States will put in place the necessary control strategies to attain the current $PM_{2.5}$ and ozone standards. Some of the control strategies employed as part of the ozone RIA, in particular, were of necessity highly uncertain. As States develop their plans for attaining these standards, their NOx control strategies may differ significantly from our analysis.

- Use of Existing CMAQ Model Runs: This analysis represents a screening level analysis. We did not conduct new regional scale modeling specifically targets to NO_2; instead we relied upon impact ratios developed from model runs used in the analysis underlying the ozone NAAQS.

- Analysis Year of 2020: Data limitations necessitated the choice of an analysis year of 2020, as opposed to the presumptive implementation year of 2017. Emission inventory projections are available for 5-year increments; i.e. we have inventories for 2015 and 2020, but not 2017. In addition, the CMAQ model runs upon which we relied were also based on an analysis year of 2020.

- Unknown controls: We have limited information on available controls for some of the monitor areas included in this analysis. For example, a full set of identified controls were applied to Los Angeles County in the Ozone NAAQS RIA; because this analysis is incremental, this left no additional identified control measures to be applied, particularly because we do not have emission reduction estimates for the Port of Long Beach in our analysis.

- Limited monitoring network: For the current monitoring community-wide monitoring network, the universe of monitors exceeding the target NAAQS levels is very small. Once a network of near-roadway monitors is put in place, there could be more potential nonattainment areas than have been analyzed in this RIA.

- Actual State Implementation Plans May Differ from our Simulation: In order to reach attainment with each selected NAAQS, each state will develop its own implementation plan implementing a combination of emissions controls that may differ from those simulated in this analysis. This analysis therefore represents an approximation of the emissions reductions that would be required to reach attainment and should not be treated as a precise estimate.

- Uncertainty associated with unspecified emission reductions: As indicated above, some areas are expected to rely on unspecified emission reductions to reach attainment with the standards. The cost of implementing these measures, though estimated here based on the costs for identified controls, is uncertain.

Costs

- We do not have sufficient information for all of our known control measures to calculate cost estimates that vary with an interest rate. We are able to calculate annualized costs at an interest rate other than 7% (e.g., 3% interest rate) where there is sufficient information—available capital cost data, and equipment life—to annualize the costs for individual control measures. For the vast majority of nonEGU point source control measures, we do have sufficient capital cost and equipment life data for individual control measures to prepare annualized capital costs using the standard capital recovery factor. Hence, we are able to provide annualized cost estimates at different interest rates for the point source control measures.

- There are some unquantified costs that are not adequately captured in this illustrative analysis. These costs include the costs of federal and State administration of control programs, which we believe are less than the alternative of States developing approvable SIPs, securing EPA approval of those SIPs, and Federal/State enforcement. Additionally, control measure costs referred to as "no cost" may require limited government agency resources for administration and oversight of the program not included in this analysis; those costs are generally outweighed by the saving to the industrial, commercial, or private sector. The Agency also did not consider transactional costs and/or effects on labor supply in the illustrative analysis.

Benefits

- Benefits are most uncertain for the Los Angeles and El Paso areas because a large proportion of the $PM_{2.5}$-related benefits are based on emission reductions attributable to unidentified emission controls. It is possible that new technologies might not meet the specifications, development timelines, or cost estimates provided in this analysis, thereby increasing the uncertainty in when and if such benefits would be truly achieved.

- The gradient of ambient NO_2 concentrations is difficult to estimate due to the sparsity of the monitoring network. The 12km CMAQ grid, which is the air quality modeling resolution, may be too coarse to accurately estimate the potential near-field health benefits of reducing NO_2 emissions. These uncertainties may under- or over-estimate benefits.

- The interpolation techniques used to estimate the full attainment benefits of the alternative standards contributed some uncertainty to the analysis. The great majority of benefits estimated for the 50 ppb standard alternative were derived through interpolation. As noted previously in chapter 5, these benefits are likely to be more uncertain than if we had modeled the air quality scenario for both NO_2 and $PM_{2.5}$. In general, the VNA interpolation approach will under-estimate benefits because it does not account for the broader spatial distribution of air quality changes that may occur due to the implementation of a regional emission control program.

- There are many uncertainties associated with the health impact functions used in this modeling effort. These include: within study variability; across study variation; the application of concentration-response (C-R) functions nationwide; extrapolation of impact functions across population; and various uncertainties in the C-R function, including causality and thresholds. These uncertainties may under- or over-estimate benefits.

- Co-pollutants present in the ambient air may have contributed to the health effects attributed to NO_2 in single pollutant models. Risks attributed to NO_2 might be overestimated where concentration-response functions are based on single pollutant models. If co-pollutants are highly correlated with NO_2, their inclusion in an NO_2 health effects model can lead to misleading conclusions in identifying a specific causal pollutant. Because this collinearity exists, many of the studies reported statistically insignificant effect estimates for both NO_2 and the co-pollutants. Where available, we have selected multipollutant effect estimates to control for the potential confounding effects of co-pollutants; these include NYDOH (2006), Schwartz et al. (1994) and O'Conner et al. (2007). The remaining studies include single pollutant models.

- This analysis is for the year 2020, and projecting key variables introduces uncertainty. Inherent in any analysis of future regulatory programs are uncertainties in projecting atmospheric conditions and source level emissions, as well as population, health baselines, incomes, technology, and other factors.

- This analysis omits certain unquantified effects due to lack of data, time and resources. These unquantified endpoints include other health effects, ecosystem effects, and visibility. EPA will continue to evaluate new methods and models and select those most appropriate for estimating the benefits of reductions in air pollution. Enhanced collaboration between air quality modelers, epidemiologists, toxicologists, ecologists, and economists should result in a more tightly integrated analytical framework for measuring benefits of air pollution policies.

- $PM_{2.5}$ co-benefits represent a substantial proportion of total monetized benefits (97% to 99% of total benefits for the 50 ppb standard), and these estimates are subject to a number of assumptions and uncertainties.

- $PM_{2.5}$ co-benefits were derived through benefit per-ton estimates, which do not reflect local variability in population density, meteorology, exposure, baseline health incidence rates, or other local factors that might lead to an over-estimate or under-estimate of the actual benefits of controlling directly emitted fine particulates.

- We assume that all fine particles, regardless of their chemical composition, are equally potent in causing premature mortality. This is an important assumption, because $PM_{2.5}$ produced via transported precursors emitted from EGUs may differ significantly from direct $PM_{2.5}$ released from diesel engines and other industrial sources, but no clear scientific grounds exist for supporting differential effects estimates by particle type.

- We assume that the health impact function for fine particles is linear within the range of ambient concentrations under consideration. Thus, the estimates include health benefits from reducing fine particles in areas with varied concentrations of $PM_{2.5,}$ including both regions that are in attainment with fine particle standard and those that do not meet the standard down to the lowest modeled concentrations.

- To characterize the uncertainty in the relationship between $PM_{2.5}$ and premature mortality (which typically accounts for 85% to 95% of total monetized benefits), we include a set of twelve estimates based on results of the expert elicitation study in addition to our core estimates. Even these multiple characterizations omit the uncertainty in air quality estimates, baseline incidence rates, populations exposed and transferability of the effect estimate to diverse locations. As a result, the reported confidence intervals and range of estimates give an incomplete picture about the overall uncertainty in the $PM_{2.5}$ estimates. This information should be interpreted within the context of the larger uncertainty surrounding the entire analysis.

Screening-level near-roadway analysis

- Due to the absence of a near-roadway monitoring network, this is a screening level analysis with several simplifying assumptions. It is provided to give a rough projection of the costs and benefits of attaining a revised NO_2 standard based on a yet to be established monitoring network.

- This analysis does not take into account a large variety of localized conditions specific to individual monitors; instead, the analysis attempts to account for some local parameters by adjusting future design values based on average localized impacts near roads from onroad emissions.

- The process of adjusting from a specific 12 km CMAQ receptor to a near-road air quality estimate represents an uncertain approximation at the specific monitor level.

- This analysis is an approximation in that it derives future year (2020) **peak** air quality concentrations in specific locations by relying on CMAQ estimates that are averages over a 12 km grid square.

- This analysis cannot predict air quality in locations for which there is no current NO_2 monitor, or where current monitoring data is incomplete. There are 142 CBSAs for which we are proposing to add new near-road monitors. Of these, 73 either have no existing monitor in the CBSA, or have a monitor with data not complete enough to include in the near-roadway analysis. In these CBSAs, extrapolation to near-roadway levels is not possible.

- This analysis assumes area-wide monitors remain in the same location; however concentrations are adjusted to reflect near-roadway conditions.

- Because the emission reductions in this analysis are solely reductions from mobile sources, this analysis uses an estimated cost per ton for NOx emission reductions that is different from the estimated cost per ton for NOx emission reductions used in the main body of the RIA.

- This analysis omits certain unquantified effects due to lack of data, time and resources. These unquantified endpoints include NO_2 health effects, ozone co-benefits, ecosystem effects, and visibility.