United States Environmental Protection Agency

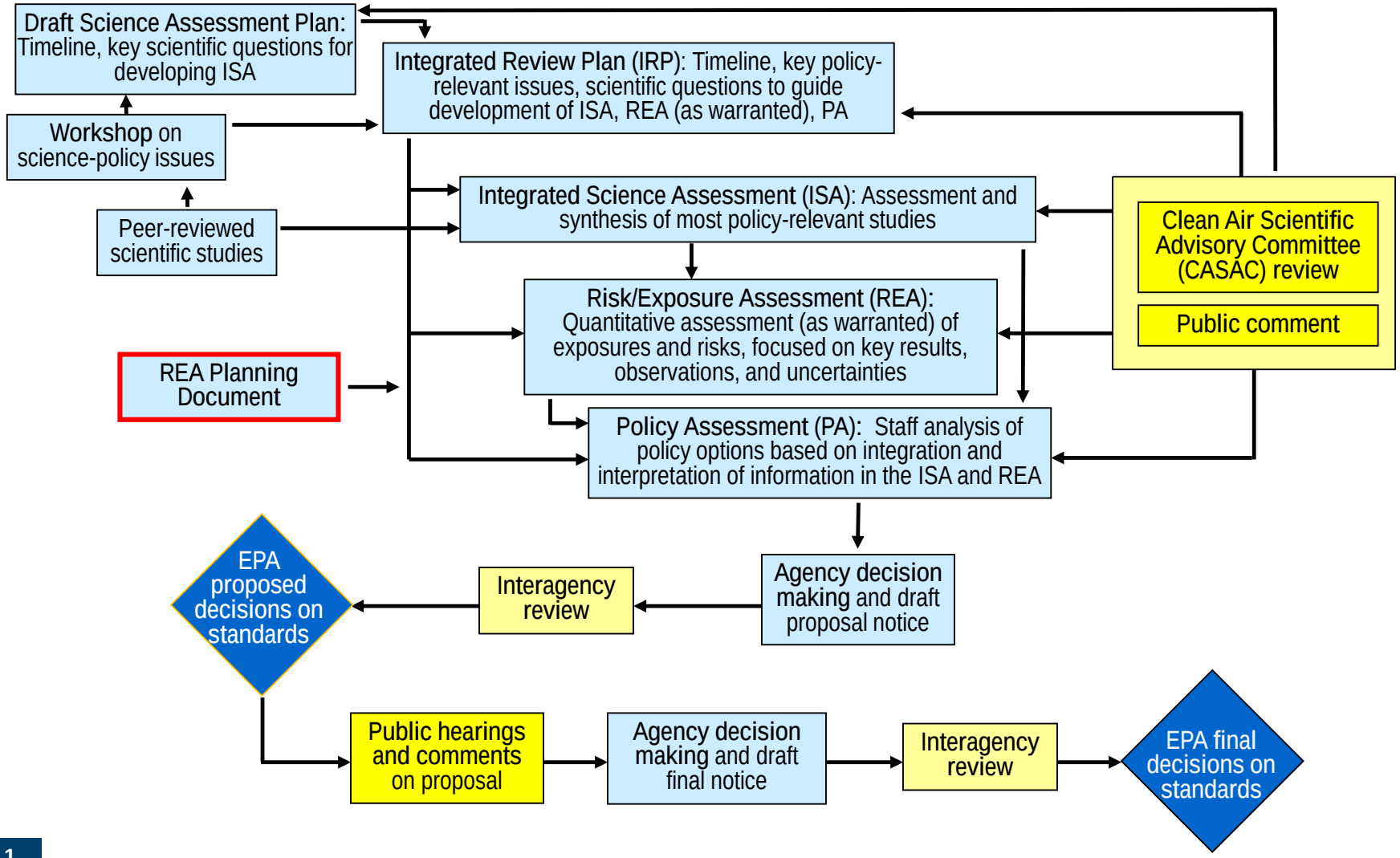
NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS):

NO_2 REA PLANNING DOCUMENT

Presentation for CASAC

June 3, 2015
Raleigh, NC

Overview of Review Process for NO_2 Primary NAAQS



Tentative Schedule for Current Review of Primary NO_2 NAAQS

Stage of Review	Major Milestone	Target Date
Integrated Review Plan (IRP)	Final IRP	June 2014
Integrated Science Assessment (ISA)	1st draft ISA	November 2013
	CASAC public meeting for review of the 1st draft ISA	March 12-13, 2014
	2nd draft ISA	January 2015
	CASAC review of the 2nd draft ISA	June 2-3, 2015
	Final ISA	Fall 2015
Risk/Exposure Assessment (REA)	REA Planning Document	May 4, 2015
	CASAC review of REA Planning Document	June 2-3, 2015
Policy Assessment (PA) including quantitative analyses - Or - Risk and Exposure Assessment (REA) and PA	1st draft	Spring/Summer 2016

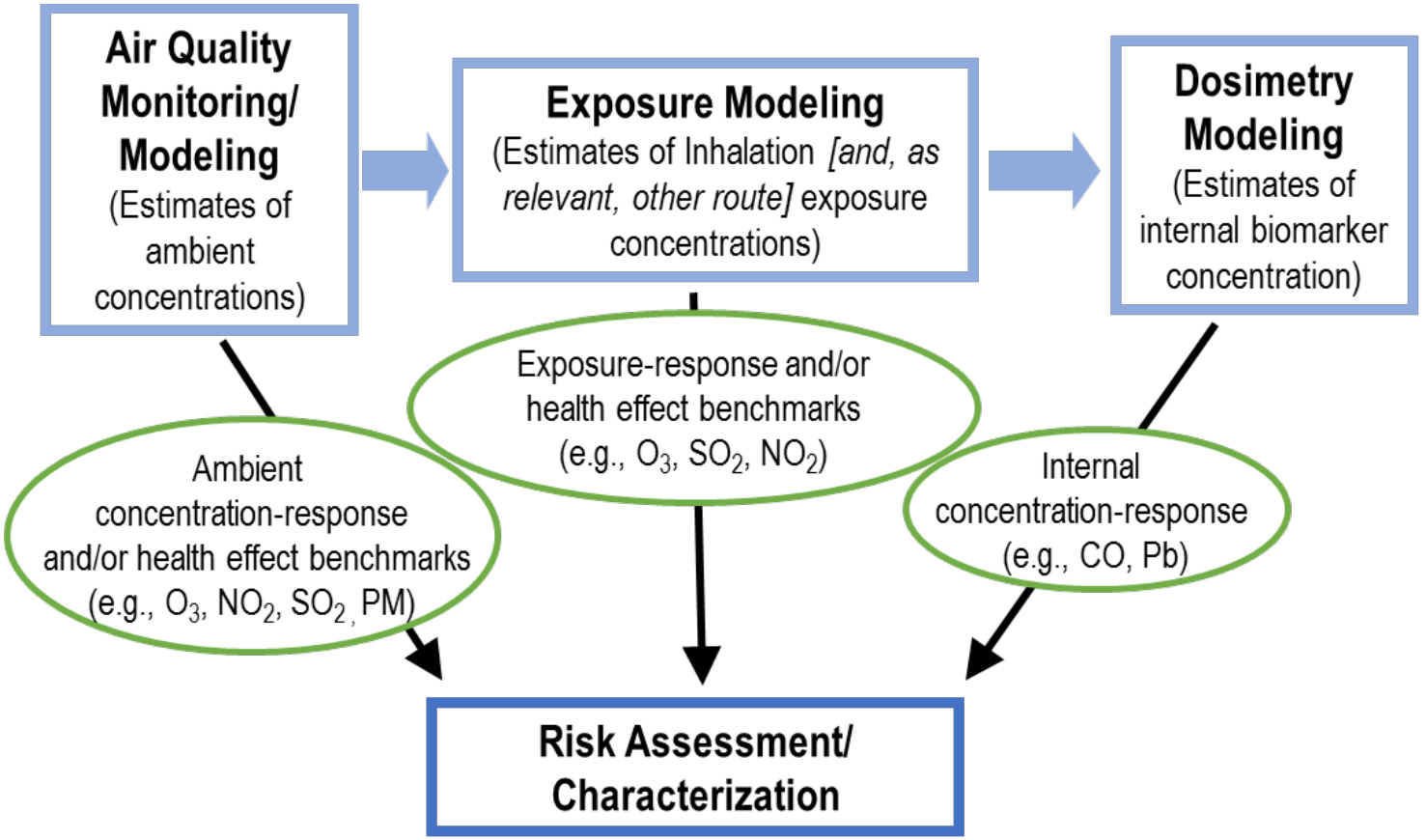
Overview of Planning Document

- Chapter 1: Introduction, History, and Approach
- Chapter 2: Air Quality and Health Benchmark Comparison
- Chapter 3: Human Exposure Assessment
- Chapter 4: Human Health Risk Assessment

History of Primary NO_2 NAAQS

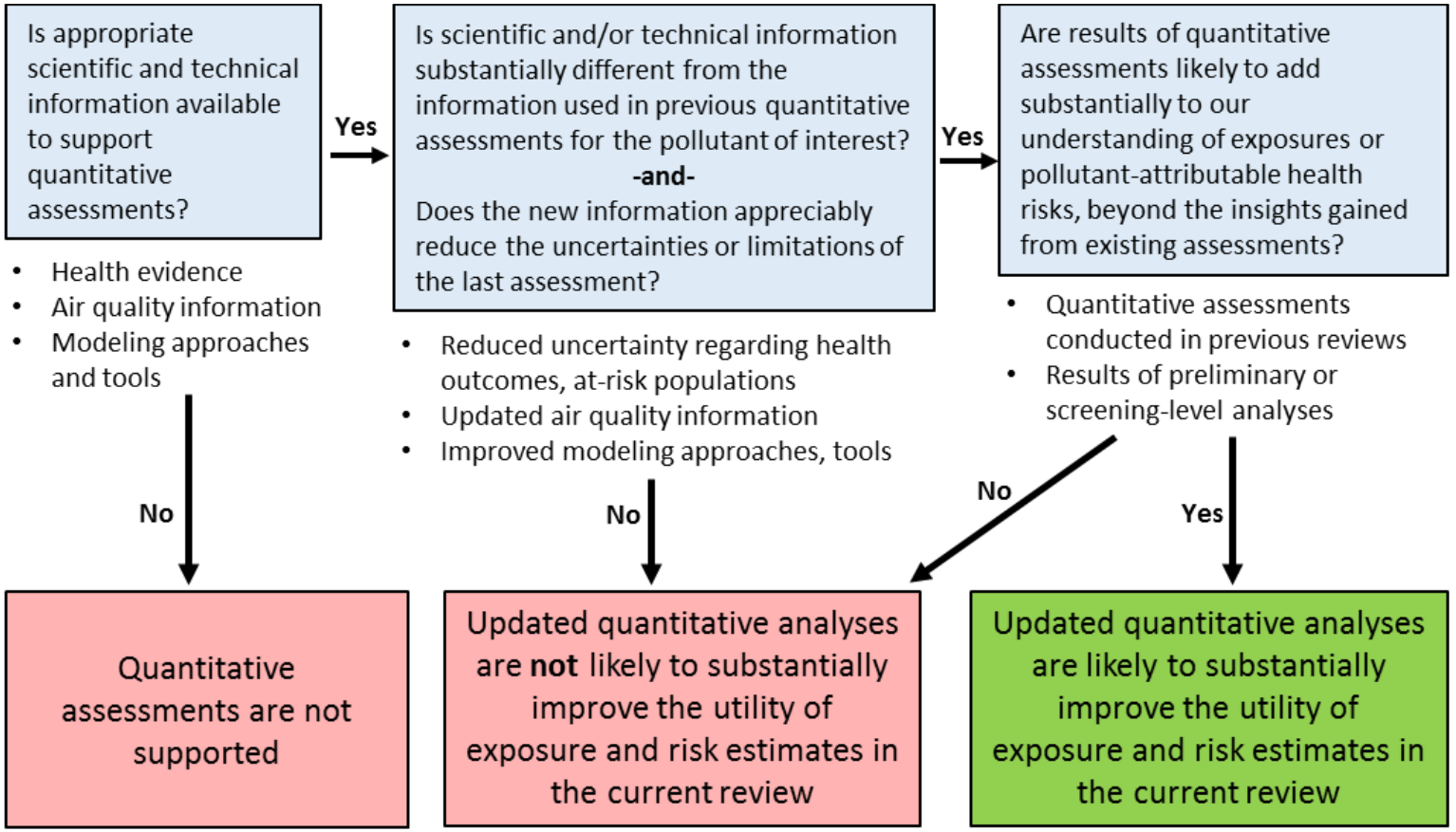
- 1971: Established annual NO_2 standard with a level of 53 ppb
- 1985 and 1996: Retained annual standard
- 2010: Established an additional 1-hour standard with a level of 100 ppb (98th percentile, averaged over 3 years); annual standard was also retained
  - ISA meta-analysis of controlled human exposure studies indicated increased airway responsiveness in people with asthma following exposures at/above 100 ppb
  - Epi studies reported associations with respiratory-related hospital admissions and emergency department visits
  - REA analyses:
    - Compared "adjusted" NO_2 concentrations across U.S. to health benchmarks ranging from 100 to 300 ppb (benchmarks based on ISA meta-analysis)
    - Estimated NO_2 exposure concentrations in Atlanta were compared to health benchmarks
    - NO_2-associated emergency department visits estimated in Atlanta, based on epi study
- 2010: Required the addition of monitors near major roadways in order to capture the highest concentrations likely to occur in many urban areas

Chapter 1: Overview of NAAQS Risk Characterization Approaches



- Figure 1-1. Risk characterization models employed in NAAQS reviews

Chapter 1: Overview of Decision Framework



- Figure 1-3. Key considerations for updated quantitative analyses.

Chapter 2: Air Quality and Health Benchmark Comparison – *Last Review*

- Approach: Compared ambient concentrations to health effect benchmarks
  - Ambient concentrations measured at existing monitoring sites and simulated on/near-roads
  - Health effect benchmarks: 100-300 ppb based on non-specific airway responsiveness in people with asthma following NO_2 exposures ranging from 0.5 to 2 hours
  - Air quality for existing conditions, adjusted upward to just meet the annual standard, and adjusted to just meet potential 1-hour standards (proportional adjustment approach used)
- Key results
  - Analyses estimated higher NO_2 concentrations on/near roads than at monitoring sites ≥100 meters from a road
  - Compared to the existing annual standard, when air quality was adjusted to just meet 1-hour standards with levels at or below 100 ppb, fewer days were estimated to have 1-hour NO_2 concentrations at or above health benchmarks
- Key uncertainties included:
  - Simulated on/near-road NO_2 concentrations
  - Adjusted NO_2 air quality, just meeting various standards
  - Interpretation of health effect benchmarks

Chapter 2: Air Quality and Health Benchmark Comparison – *Current Review*

- New information available for this review includes:
  - Ambient NO_2 concentrations at new near-roadway monitors
  - Additional on- and near-road measurement research studies
  - Updated statistical and air quality model-based approaches to simulate on-/near-road concentrations
  - Alternative approach to adjust air quality to just meet the standards
- Preliminary Conclusions:
  - There is a substantially improved body of information available in the current review to inform an updated characterization of 1-hour NO_2 concentrations around roadways
  - New information is expected to provide important perspective, beyond what is available from the last review, on the extent to which NO_2 exposures on and near roads could have important implications for public health
  - Therefore, an updated analysis comparing ambient NO_2 concentrations to health effect benchmarks is supported in the current review, with a particular focus on updating analyses of concentrations on and near major roadways

Chapter 2: New Information from Near-Road Monitors

Near-road NO_2 Monitoring			
Implementation Phase	CBSA Population	Required Start Date	Status[1]
Phase 1 52 Sites	≥ 1 Million	Jan 1, 2014	45 sites operational
Phase 2 23 Sites	≥ 2.5 Million OR road segment ≥250,000 AADT	Jan 1, 2015 (2nd site)	9 sites operational
Phase 3 51 Sites	Between 500,000 and 1 Million	Jan 1, 2017	2 sites operational

[1] Many sites do not yet have a complete year of data available for analysis.

Chapter 2: Study Area Selection (1)

- Selection Criteria
  1. Number of ambient monitors (area wide, near-road, background, other potentially high NO_2 concentration environments) in Core Based Statistical Areas (CBSAs)
  2. CBSAs having monitors with the highest annual and daily maximum 1-hour (DM1H) NO_2 design values
  3. CBSA population (highest)
  4. Availability of monitor meta-data (proximal NO_X emission sources, land-use, objective, measurement scale), historical concentrations, intra- and inter-monitor NO_2 concentration ranges and correlations
- Applying these four criteria resulted in 16 CBSAs identified as "strong" candidates and 9 CBSAs identified as "possible" candidates
  - Most strong candidates (12 of 16) have new near-road monitor data
  - Half of strong candidates (8 of 16) were evaluated in 2008 NO_2 REA

Chapter 2: Study Area Selection (2)

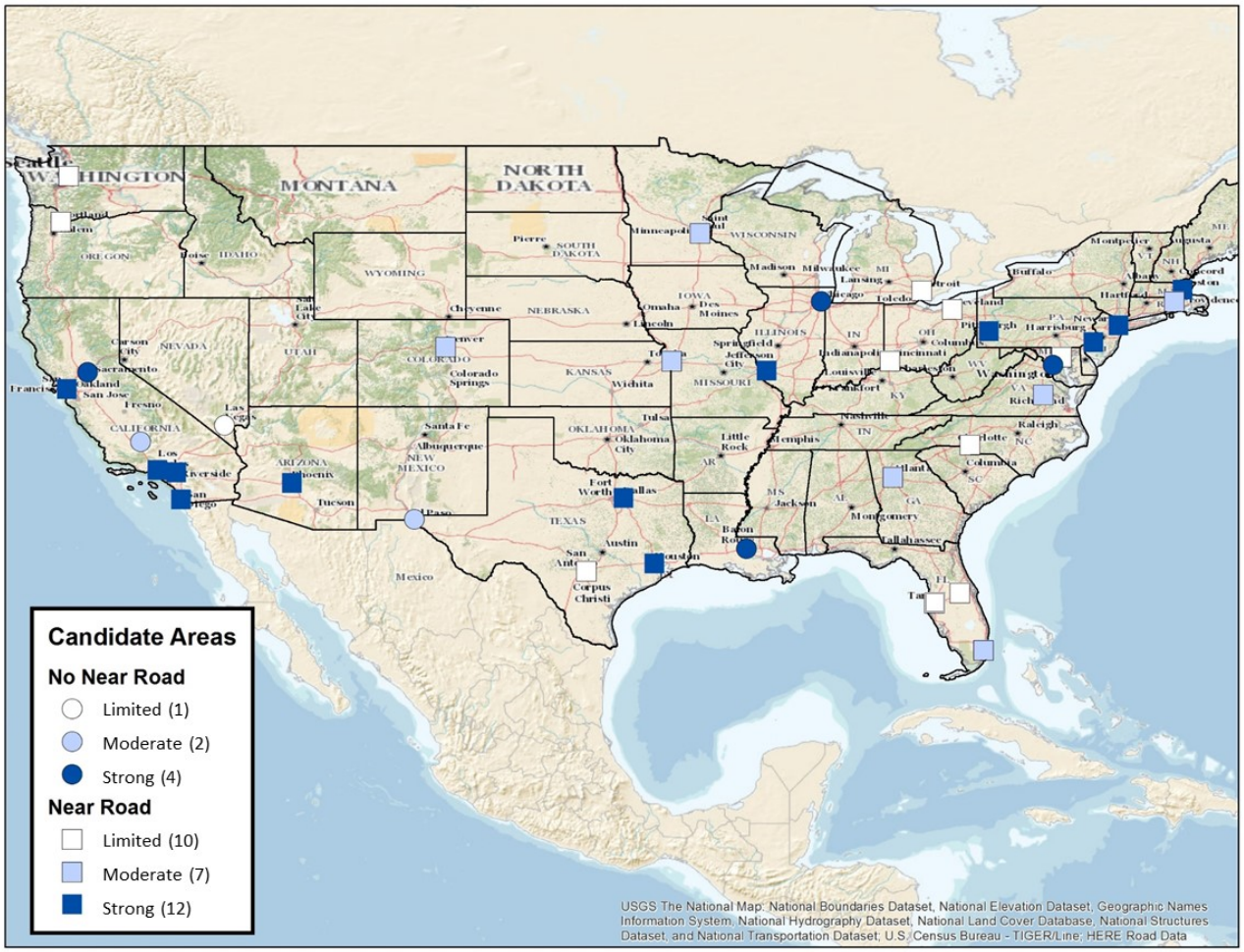


Figure 2-1, 2015 NO_2 REA Planning Document. Corrected to reflect 16 "strong" candidates, 9 "possible" additional candidates, and the 11 next most populated CBSAs having limited supporting data.

Chapter 2: Air Quality Adjustment

- Proposed approach to adjust ambient NO_2 upward to just meet the existing standards, and alternatives if evaluated
  - Step 1: Proportionally adjust minimum to 98th pct DM1H
    - using a single factor derived from highest design value in CBSA
    - applied equally to all monitors (similar to 2008 NO_2 REA)
  - Step 2: Non-linear adjustment for concentrations > 98th pct DM1H
    - using individual monitor-derived ratios of these upper percentile concentrations to the 98th pct DM1H (new approach)

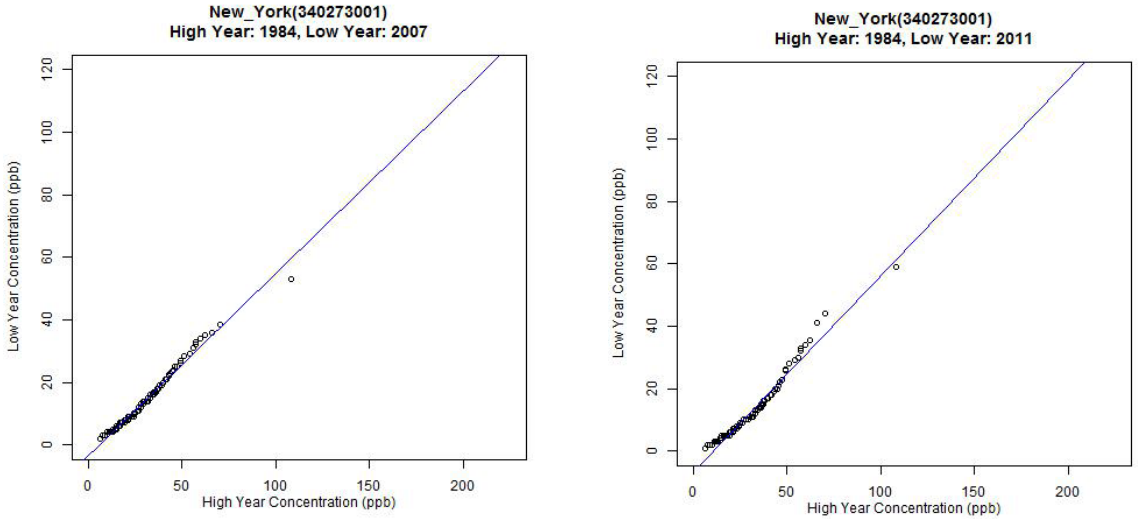


Figure 2-2, 2015 NO_2 REA Planning Document. Distribution of DM1H NO_2 concentrations (0 – 100th percentile) in the New York CBSA for a high-concentration year (1984) versus a low-concentration year (2007) adapted from Rizzo (2008) (left panel) and updated comparison with a recent low-concentration year (2011) (right panel).

Chapter 2: On-Road Simulation

- Based on all available data reviewed, on-road NO_2 concentrations are expected to be higher than concentrations immediately away from roads.
- Proposed approach to simulate on-road NO_2 concentrations (to serve as a surrogate for potential in-vehicle exposures):
  - Step 1: Use measured concentrations (new near-road monitor data, where available) as a starting point
  - Step 2: Apply simulation factor(s) to increase measured concentrations using information derived from:
    - on-road and immediate near-road NO_2 concentrations from measurement studies;
    - statistically modeled on-road concentrations derived from analysis of near-road NO_2 measurement transect study data (similar to 2008 NO_2 REA); and/or
    - modeled NO_2 concentrations at on-road and near-road receptors
  - Based on preliminary analyses, simulated on-road concentrations could be about 6% to 35% higher than concentrations at near-road monitoring sites, depending on distance from road and other factors

Chapter 2: Example Study Area & Preliminary Results

- Philadelphia CBSA (2011-2014)
  - Locations include industrial, residential (urban-core and suburban), agricultural areas, and a newly sited near-road monitor
  - Compared area-wide, near-road, and simulated on-road NO_2 concentrations to health effect benchmarks
    - 'As is' conditions (not shown): No exceedances of any benchmarks
    - Air quality adjusted to just meet the 1-hour standard (Table): Numbers of estimated exceedances are similar to numbers in past years when conditions existed that just met 1-hour standard

PHILADELPHIA CBSA: Days per year with 1-hour NO_2 **Concentrations ≥ Health Benchmarks** (Air quality adjusted to just meet the existing standards)

		DM1H ≥ 100 ppb		DM1H ≥ 200 ppb	
	Year	Mean	Max	Mean	Max
Area-Wide	2011	6	23	0	0
	2012	2	4	0	0
	2013	1	2	0	0
	2014 [a]	3	6	0	0
Near-Road	2014 [a]	-	5	-	0
Simulated On-Road	2014 [a]	-	6	-	0

From Table 2-14, 2015 NO_2 REA Planning Document.
[a] The monitoring data available for 2014 are not for a full year (i.e., the near-road monitor has data for quarters 1 through 3).

Chapter 2: Next Steps for Air Quality and Health Benchmark Comparisons

- Expanding upon preliminary analyses, compare adjusted ambient NO_2 concentrations to health effect benchmarks for additional study areas
- Results of expanded analyses will inform EPA's consideration of the potential utility of an updated assessment of personal NO_2 exposures (Chapter 3)
  - If analyses indicate little potential for population exposures to ambient NO_2 concentrations of public health concern, there would be limited value added by more refined estimates of personal NO_2 exposures
  - If analyses indicate the potential for NO_2 exposures of public health concern, more refined estimates of NO_2 exposures could be supported

Chapter 3: Human Exposure Assessment – *Last Review*

- Approach: Compared estimates of daily maximum 1-hour exposure concentrations (DM1H) to 1-hour health effects benchmarks (100-300 ppb)
  - DM1H exposures estimated in Atlanta using dispersion (AERMOD) and exposure (APEX) modeling
  - Air quality for existing conditions, adjusted upward to just meet the existing annual standard, and adjusted to just meet potential 1-hour standards
- Key Results
  - Roadway-related exposures accounted for more than 99% of exposures to NO_2 concentrations at or above 1-hour health effect benchmarks in Atlanta
  - When air quality was adjusted to just meet the existing annual standard in Atlanta, almost all people with asthma were estimated to experience 1-hour exposures to NO_2 concentrations at or above 300 ppb at least six times per year
  - Compared to the existing annual standard, when air quality was adjusted to just meet 1-hour standards with levels at or below 100 ppb, fewer exposures at or above benchmarks were estimated
- Key Uncertainties included:
  - Mobile source emissions and diurnal profiles used
  - APEX on-road concentration estimation approach
  - Limits in linking commute times with activity pattern drive times

Chapter 3: Human Exposure Assessment – *Current Review*

- Newly available information includes:
  - Updated Emissions and Profiles
    - National Emissions Inventory (2011 NEIv2), mobile source emission factors (2014 MOVES)
  - Updated Air Quality Modeling (AERMOD)
    - Revised NO_2 chemistry options; ability to apply background concentrations
    - AERMETs use of high-resolution meteorological data
  - Updated Exposure Modeling (APEX)
    - Demographics, commuting, and activity pattern databases
    - Microenvironmental concentration options
- Preliminary conclusion: To the extent analyses comparing air quality with health effect benchmarks indicate the potential for the current NAAQS to allow NO_2 exposures of public health concern, more refined model-based estimates of NO_2 exposures would be supported in the current review
- If an updated exposure assessment is conducted, we would use new information to estimate exposures in selected study areas with an approach similar to that used in the 2008 NO_2 REA

Chapter 4: Risk Assessment Based on Controlled Human Exposure Studies

- Last Review: Available data from controlled human exposure studies was not adequate for use in a quantitative assessment of health risks
  - Considerable variability in protocols, measurement approaches, and results across studies
  - Lack of strong evidence indicating the existence of an exposure-response relationship
- Current Review: Preliminary conclusion is that a quantitative risk assessment based on information from controlled human exposure studies is not supported by the available evidence
  - Evidence from controlled human exposure studies essentially unchanged since last review

Chapter 4: Risk Assessment Based on Epidemiology Study Information

- Last Review: Respiratory-related emergency department (ED) visits associated with short-term ambient NO_2 estimated in Atlanta, concentration-response (C-R) functions from Tolbert et al. (2007)
  - Compared to the existing annual standard, adjusting air quality to just meet 1-hour standards with levels at or below 100 ppb reduced estimates of respiratory-related ED visits in Atlanta
  - Risk estimates based on co-pollutant models remained positive, though smaller, and confidence intervals were wider than estimates based on the single pollutant model
  - Key Uncertainties included:
    - NO_2 coefficients in C-R functions used in the assessment
    - Specification of the risk model (including shape, existence of a threshold)
    - Confounding by co-occurring pollutants
- Current Review - *short-term*: Uncertainties similar to last review; Preliminary conclusion is that an updated risk assessment would be unlikely to substantially improve our understanding of NO_2-attributable health risks or increase our confidence in risk estimates
- Current Review - *long-term*: Considerable uncertainty in quantifying NO_2 risks due to highly correlated co-pollutants; Preliminary conclusion is that an assessment would not substantially add to our understanding of NO_2-attributable health risks and would therefore be of limited value in informing decisions in the current review

Next Steps

- Expanding upon preliminary analyses, compare adjusted ambient concentrations to health effect benchmarks for additional study areas
- Consider results of expanded analyses in determining the utility of conducting a more refined assessment of NO_2 exposures
  - If warranted, an updated exposure assessment would use new information to estimate exposures in selected study areas
- Develop either a first draft PA, which would include any quantitative analyses conducted, or a first draft REA
- We expect to release the first draft of the PA and/or REA for CASAC review in the Spring to Summer of 2016

United States Environmental Protection Agency

Appendix

Air Quality and Health Benchmark Comparison: Benchmark Levels

- As was done in the last review, controlled human exposure study data informed our selection of 1-hour health effect benchmark levels
- Health endpoint of interest: Non-specific airway responsiveness in people with asthma following short-term (0.5 to 2 hours) NO_2 exposures
- Lowest benchmark: 100 ppb is the lowest NO_2 exposure concentration for which the evidence indicates the potential for NO_2-induced increases in airway responsiveness
- Highest benchmark: 400 ppb selected because of general consistency in observed health effects using pooled and individual study results at this or higher levels

Near-road Monitoring

Implementation Phase	CBSA Population	NO_2	CO*	$PM_{2.5}$*
Phase 1 52 Sites [funded]	≥ 1 Million	Jan 1, 2014	Jan 1, 2015 for CBSAs ≥ 2.5M Jan. 1, 2017 for CBSAs ≥ 1M and ≤ 2.5M	Jan 1, 2015 for CBSAs ≥ 2.5M Jan. 1, 2017 for CBSAs ≥ 1M and ≤ 2.5M
Phase 2 23 Sites (second sites) [funded]	≥2.5 Million **OR** road segment ≥250,000 AADT (NO_2 only)	Jan 1, 2015 (second site)		
Phase 3 51 Sites [unfunded]	Between 500K and 1 Million	Jan 1, 2017		

Near-road NO_2 Network: Operational Status

- Currently, the EPA estimates that there are 56 operational near-road monitoring sites
- Phase 1 sites: 45 of 52 sites operational
  - missing CBSAs: Chicago, Las Vegas, Orlando, Sacramento, Salt Lake City, Virginia Beach, Washington, D.C. {2nd D.C. site is operational}
- Phase 2 sites: 9 of 23 sites operational
- Phase 3 sites: Boise and Des Moines are operational
- During 2014, no near-road site had an estimated annual average for NO_2 (of all available data) above 27 ppb
- During 2014, no near-road site had an estimated daily max 1-hour 98th percentile value for NO_2 (of all available data) above 90 ppb

Near-road Sites: Multi-pollutant

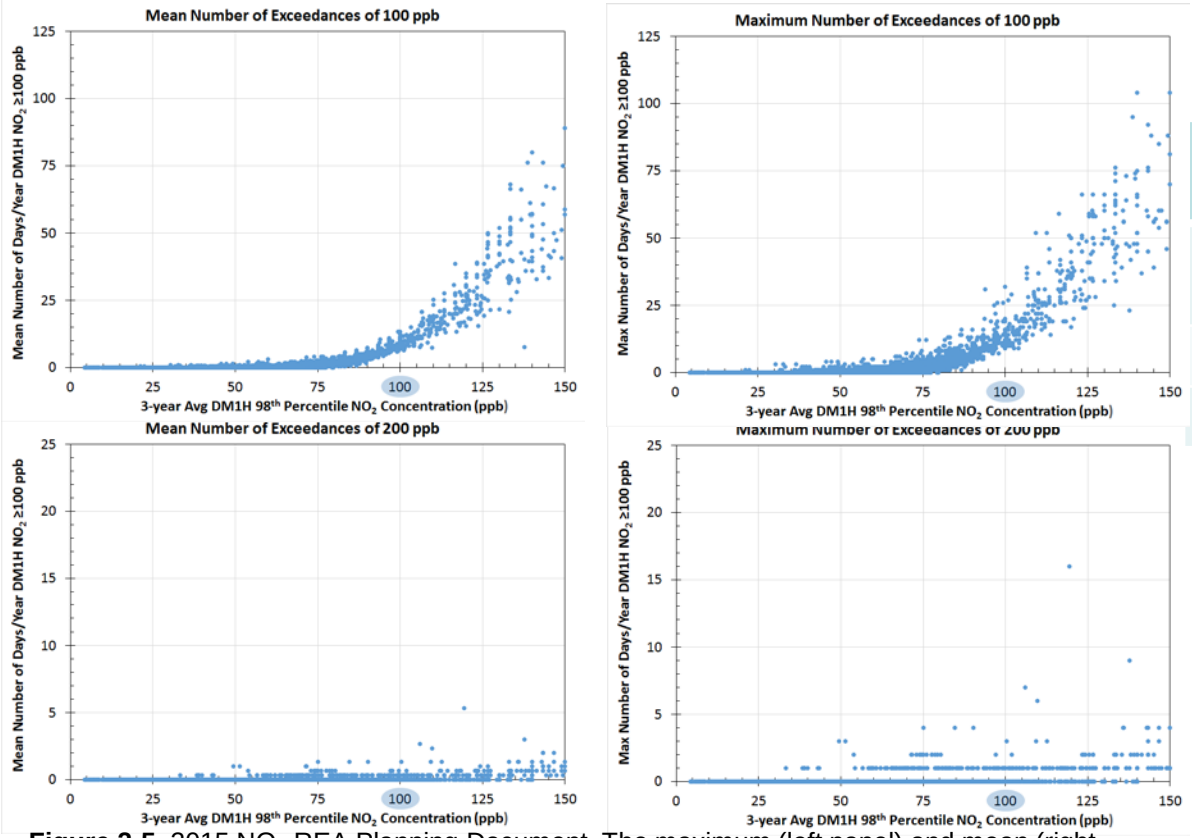
- These sites have always been envisioned to be multipollutant

- In addition to NO_2 at all sites, we currently have:
  - 31 sites with PM2.5 instrumentation
    - 21 with continuous methods
    - 14 with filter-based FRMs
    - 4 of the 31 sites have collocated continuous & FRMs
  - 40 sites with CO instrumentation
  - 17 sites with black carbon instruments

- For a complete listing of current near-road site metadata, visit http://www.epa.gov/ttnamti1/nearroad.html

Air Quality and Health Benchmark Comparison: 'Unadjusted' Ambient NO_2

- Context for Benchmark Exceedances and Relationship to Existing 1-hour Standard using Unadjusted (as is) Ambient Monitor NO_2 Concentrations (All U.S. NO_2 Monitors, 1980-2014)



Benchmark Exceedances when 3-yr average 98th pct DM1H ~ 100 ppb		
1-hr Benchmark	**Mean (days/yr)**	**Max (days/yr)**
100 ppb	6 - 13	10 - 20
200 ppb	0 - 1	0 - 3

Figure 2-5, 2015 NO_2 REA Planning Document. The maximum (left panel) and mean (right panel) number of days per year where DM1H NO_2 concentration was ≥ 100 ppb (top panel) and ≥ 200 ppb and associated with 3-year average 98th percentile DM1H NO2 concentrations, using 1980-2014 ambient monitor data.

Philadelphia CBSA Active and Inactive Monitors

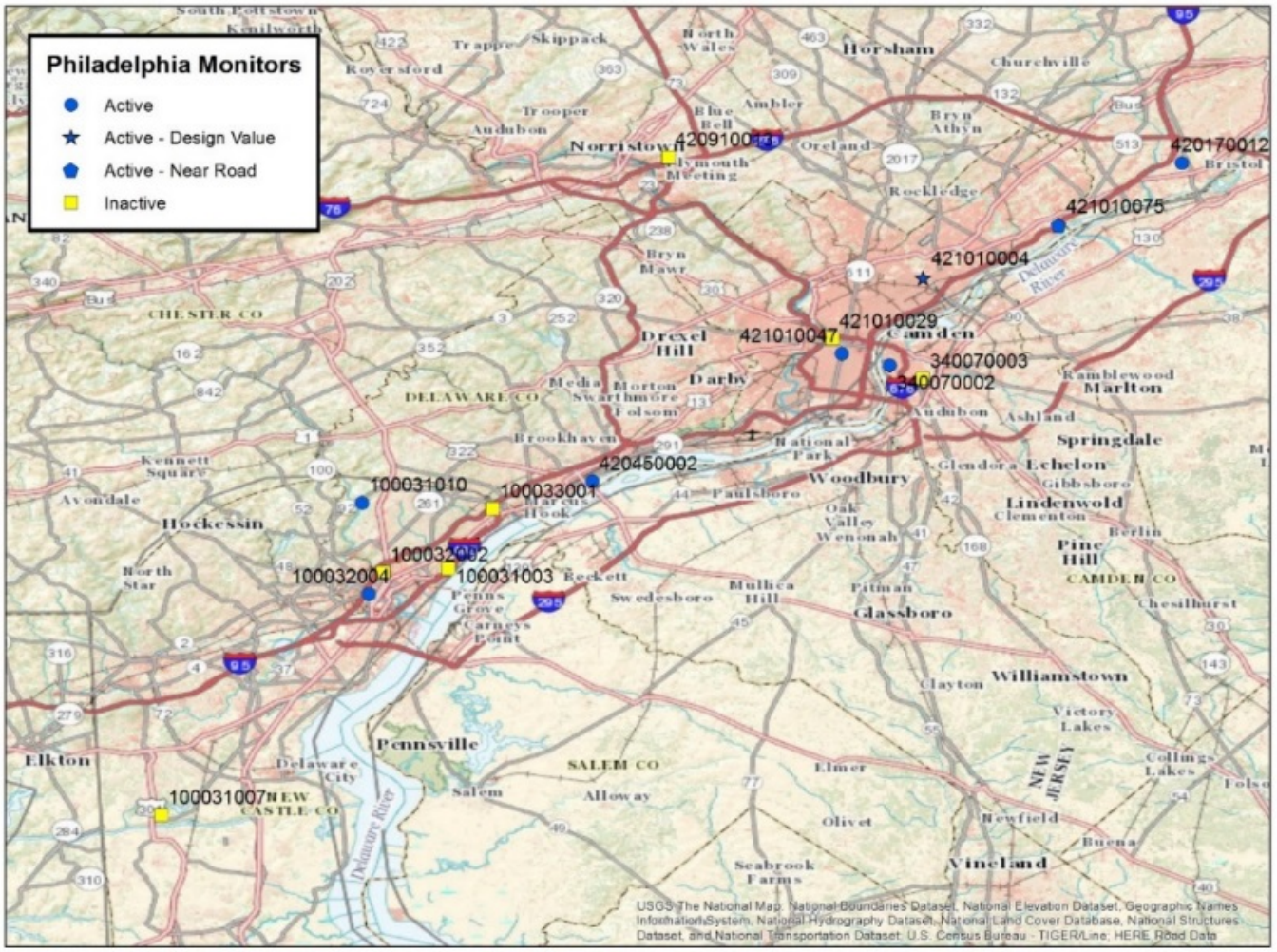


Figure 2-6, 2015 NO_2 REA Planning Document.