Air Pollution and Public Health in Minnesota

House Environment, Natural Resources and Agriculture Finance Committee

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CLEAN AIR ACT AND STANDARDS

Clean Air Act and Air Quality Standards

National Ambient Air Quality Standards (NAAQS)

- CAA requires NAAQS set at a level "requisite to protect public health"

State Implementation Plan (SIP)

- States must develop policies, rules and control requirements to ensure all areas of the state meet the NAAQS

Attainment

- States must **monitor** to demonstrate air quality meets the NAAQS

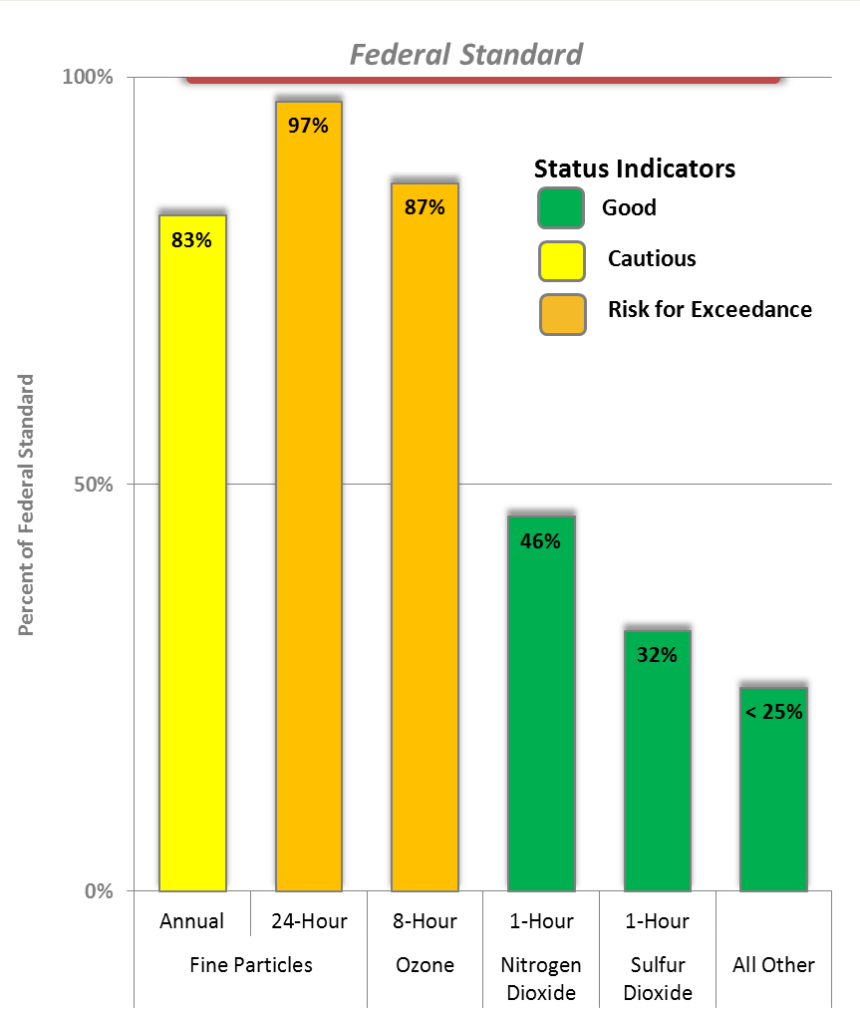
Nonattainment: Areas that violate the NAAQS must implement stringent and costly emission controls to ensure future compliance with the NAAQS

National Ambient Air Quality Standards Reviews

- NAAQS are reviewed every five years
  - Account for any new scientific information
  - Ensure they remain sufficiently health protective
  - Long process – review begins almost as soon as a standard is promulgated
- Recent flurry of review and revision of standards

National Ambient Air Quality Standards

- Six pollutants
  - Carbon monoxide
  - Lead
  - Nitrogen Dioxide (NO_2)
  - Sulfur Dioxide (SO_2)
  - Ozone
  - Particulate matter
    - Coarse (PM_{10})
    - Fine ($PM_{2.5}$)

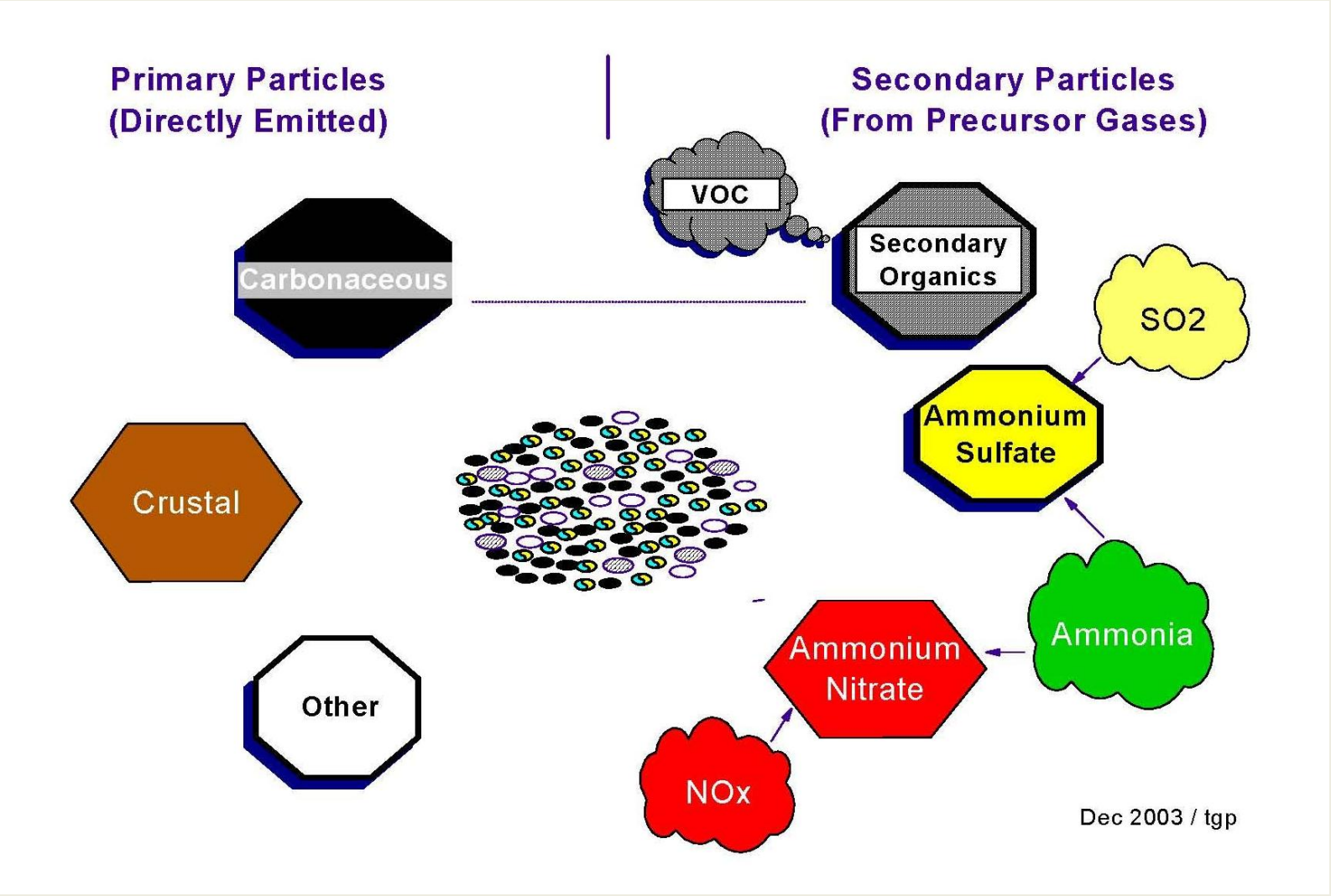


Based on 2009-2011 monitoring data

Ozone and Fine Particulate Matter ($PM_{2.5}$)

- Where Minnesota is closest to the standard
- Reducing levels requires dealing with many different emission sources
  - Moving beyond currently permitted point sources
- High pollutant levels cover and come from larger areas
  - These pollutants are formed from reactions of other pollutants
  - Many sources contribute to these pollutants
    - Particularly combustion sources
    - Groups of smaller sources are important

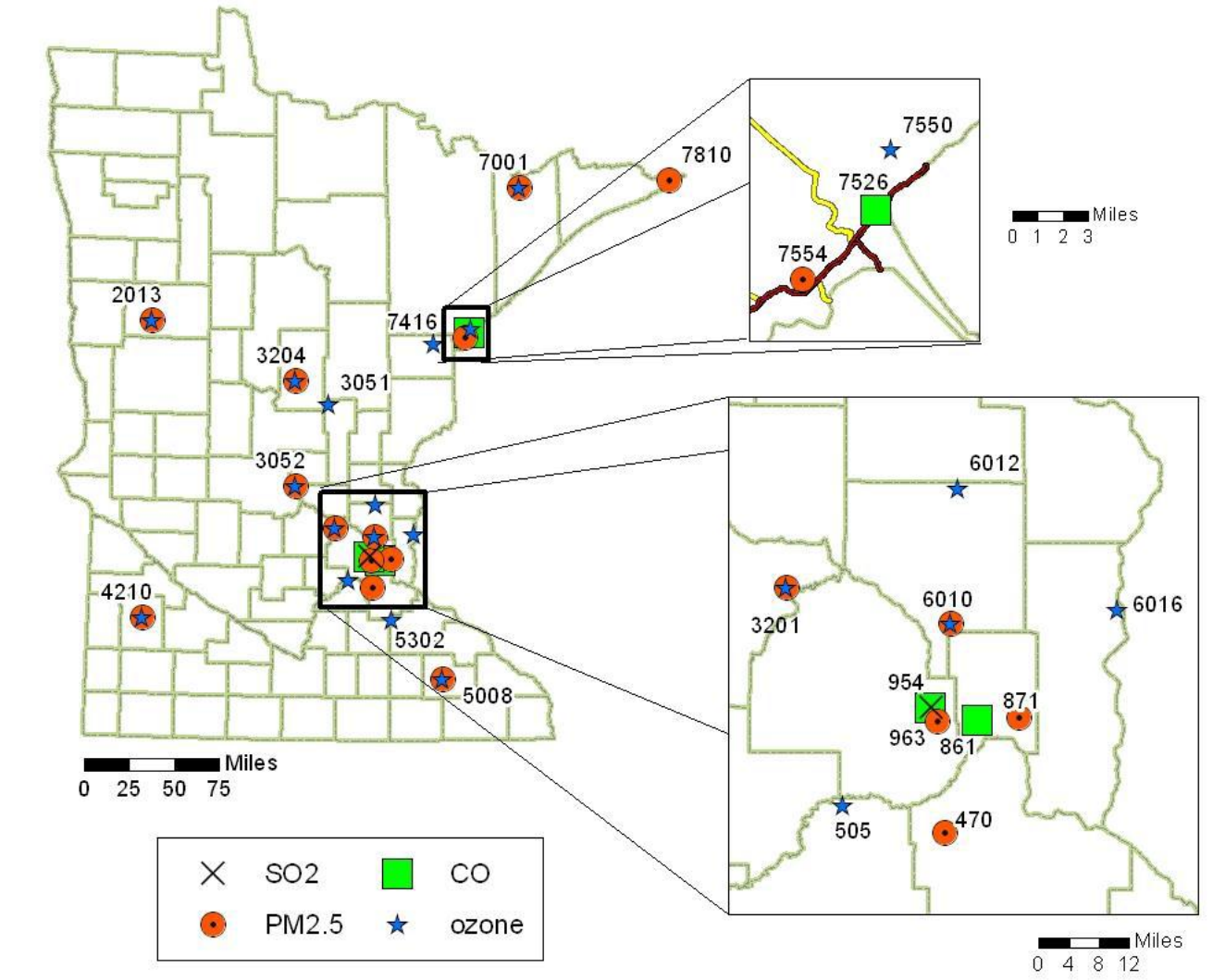
Components of $PM_{2.5}$



Measuring and Estimating Pollution

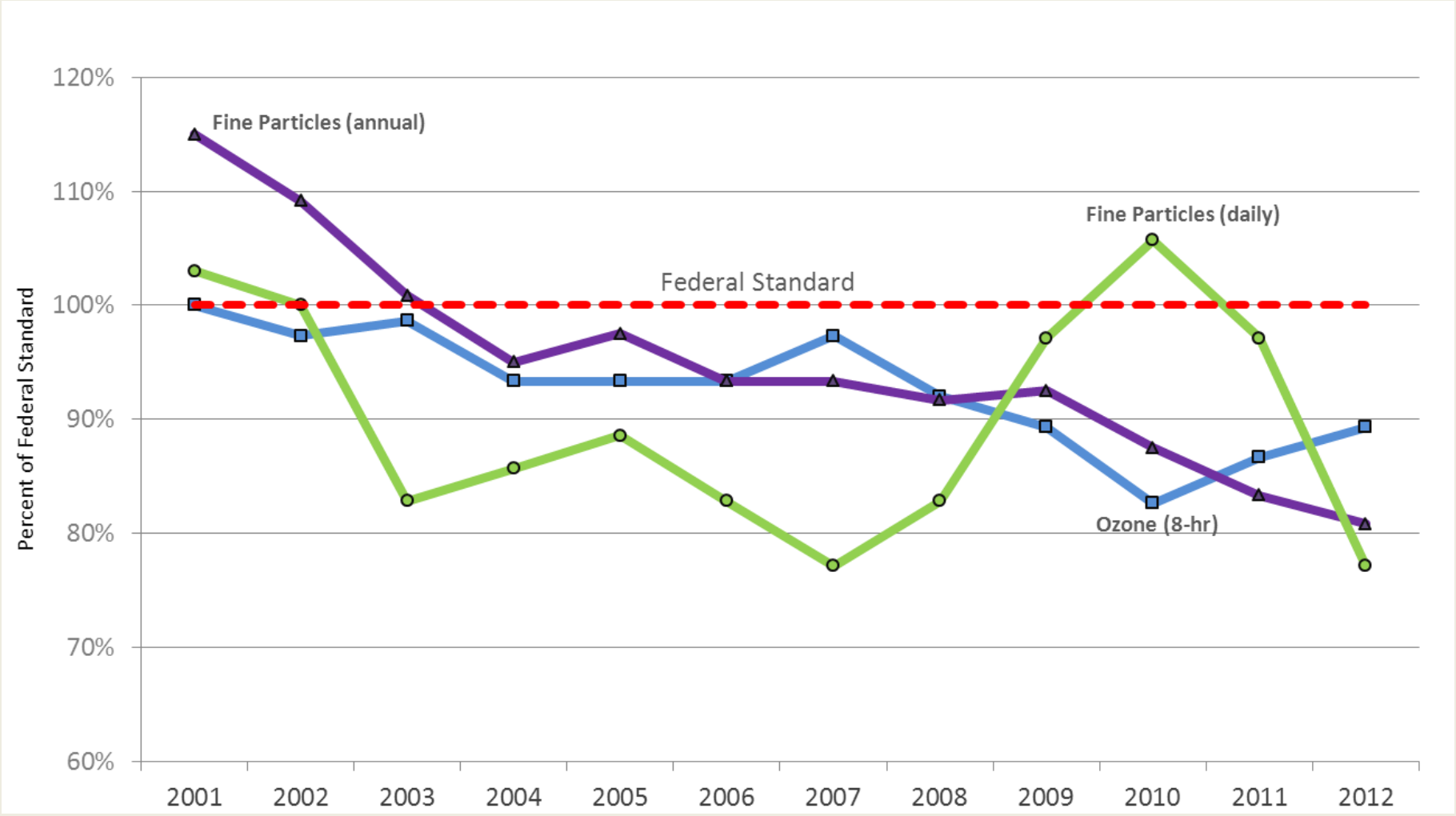
- Measured by monitors
  - Collects current pollution level
  - Cannot identify or quantify source contributions
- Estimated by models
  - Predicts future pollution level
  - Identifies and quantifies source contributions

Air Quality Index Monitoring Sites

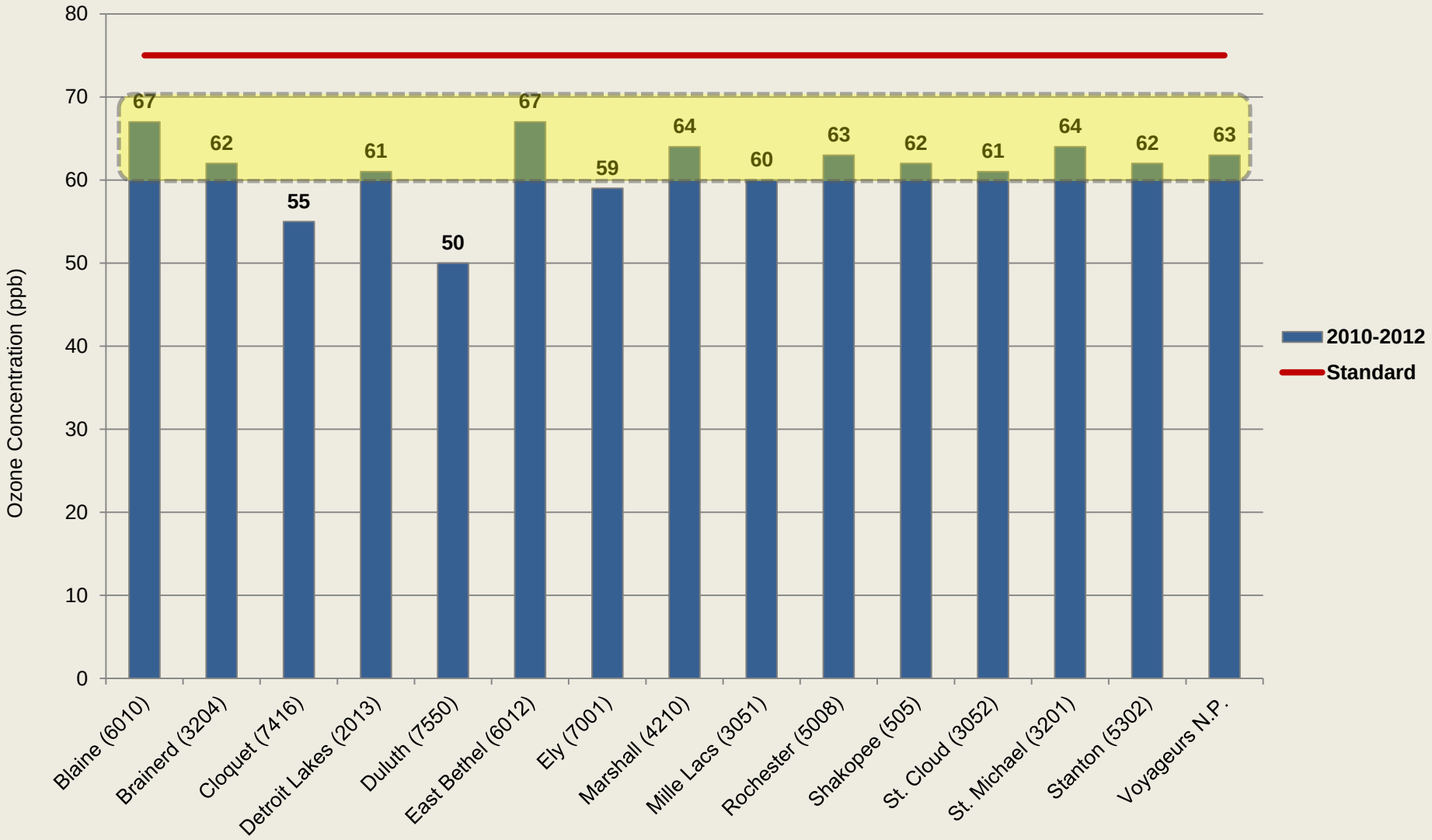


Twin Cities Metro Area Air Quality

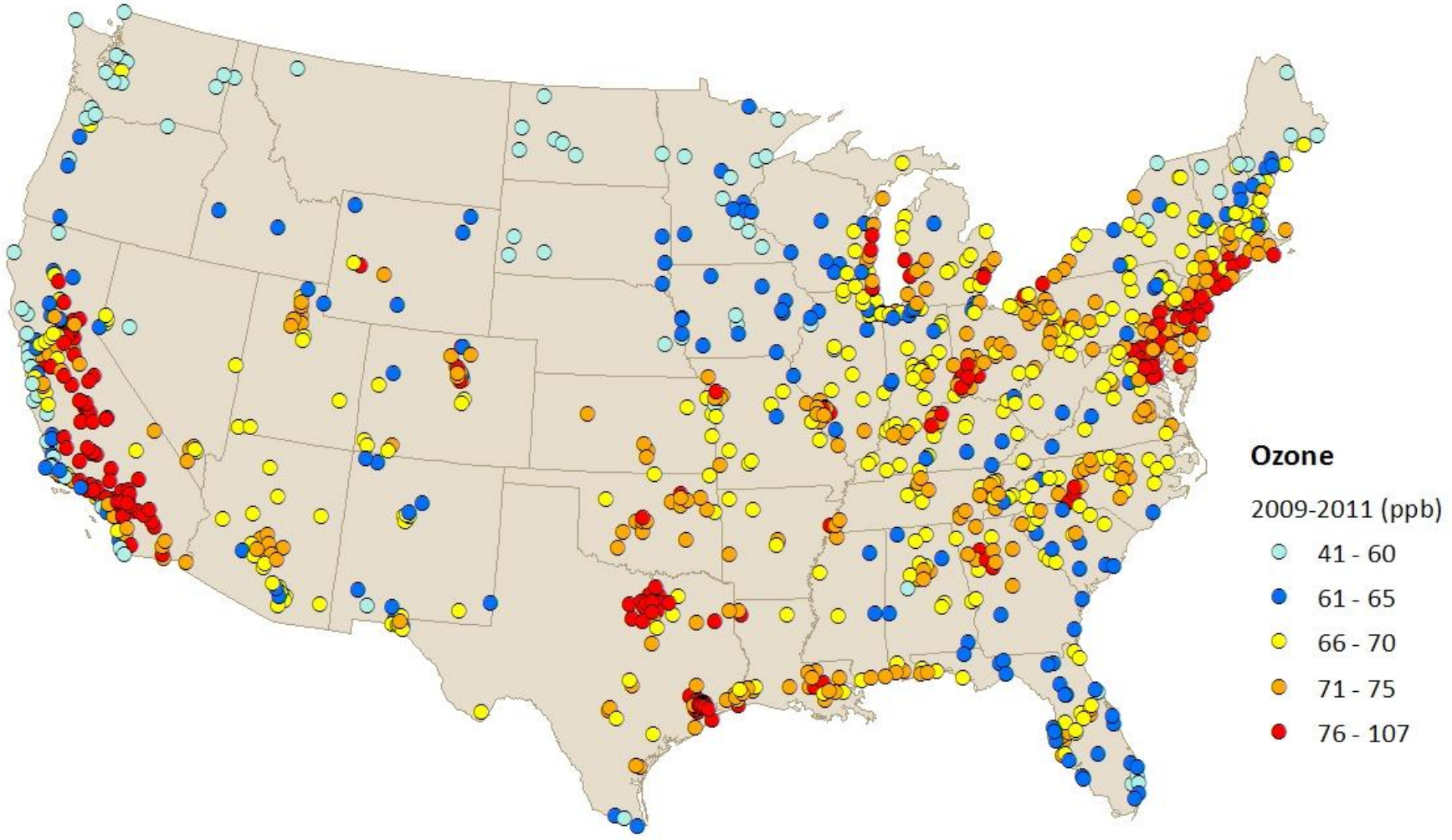
Percent of the National Ambient Air Quality Standard



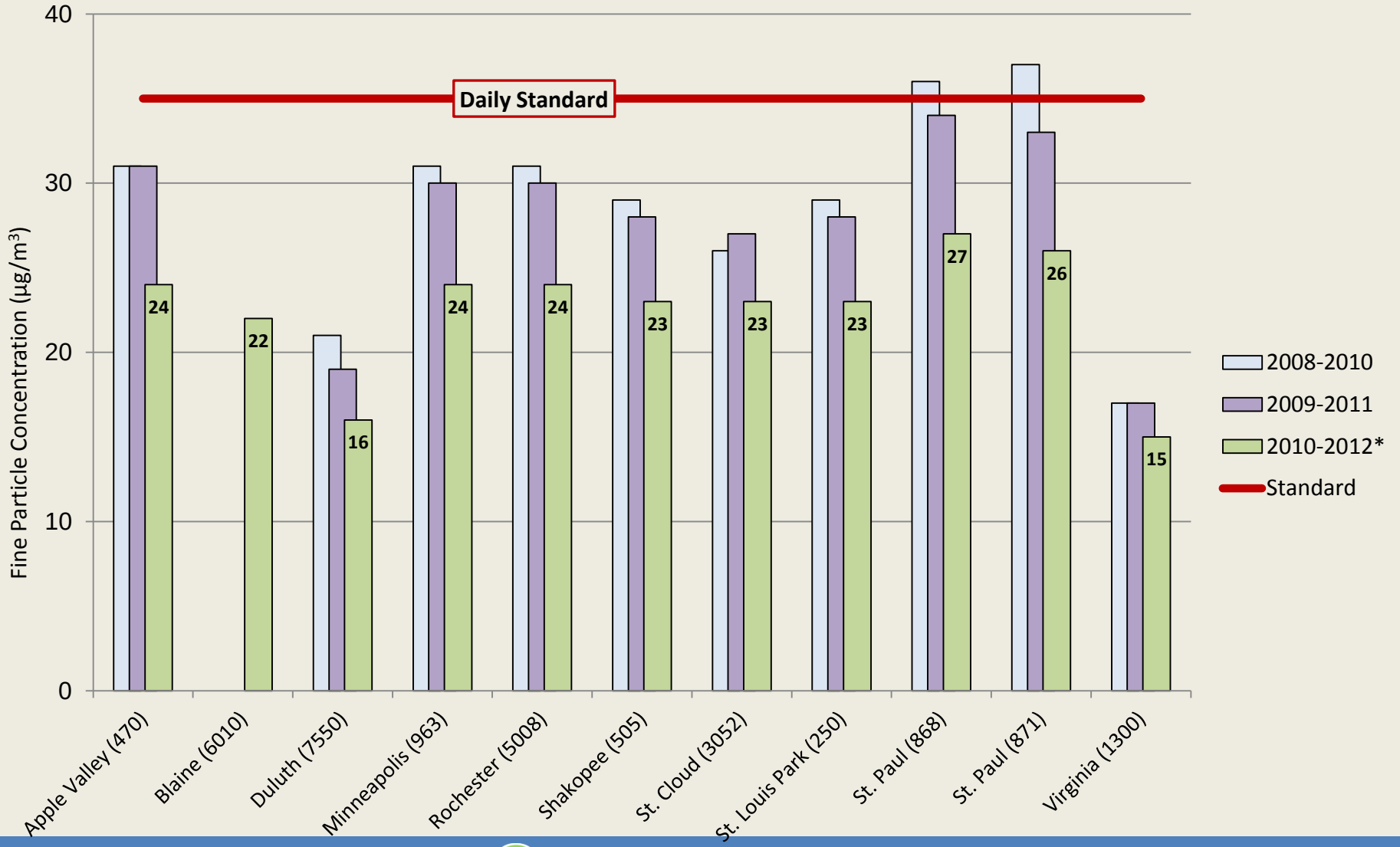
Minnesota Ozone Levels



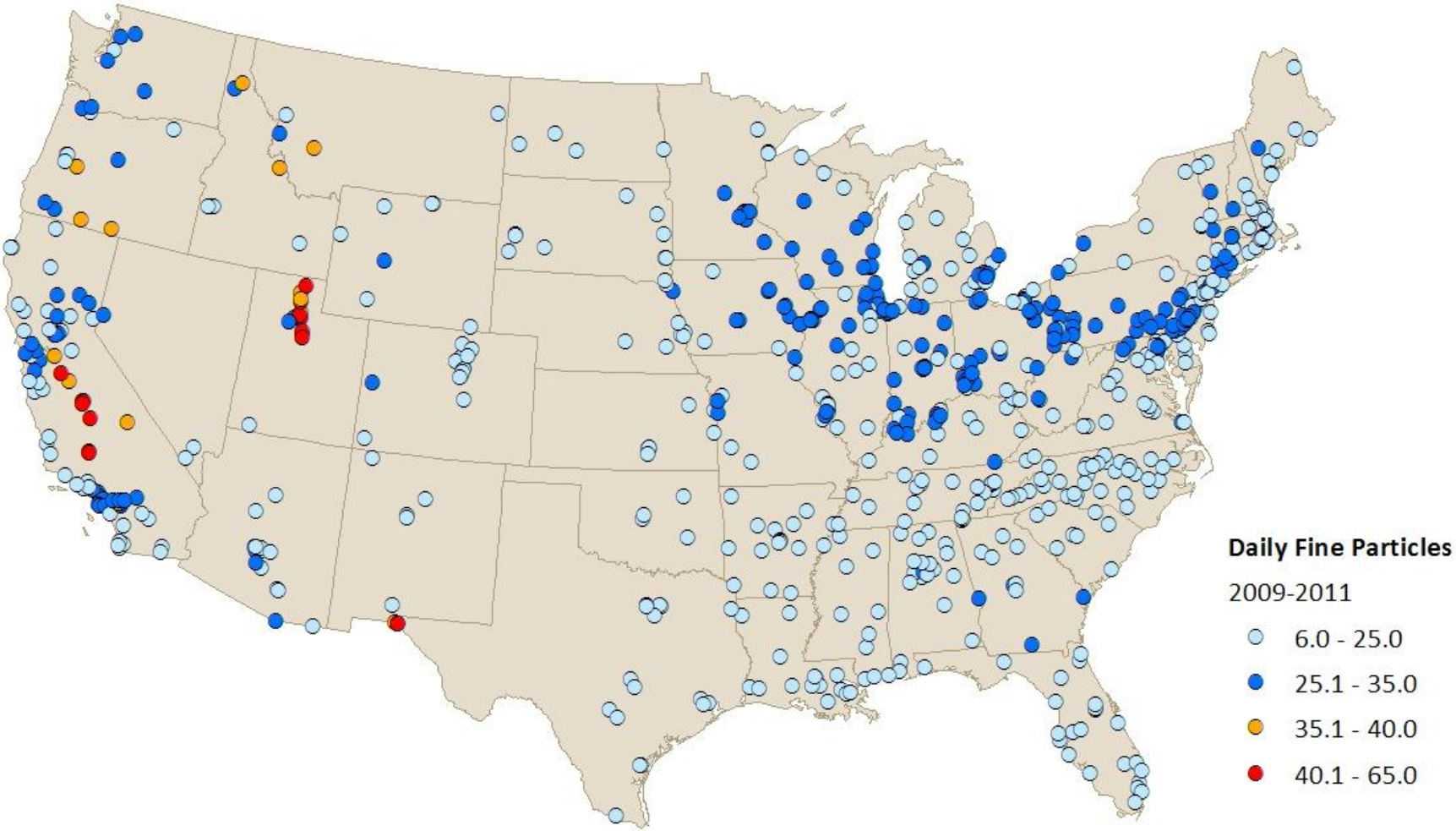
National Ozone Concentrations, 2009-2011



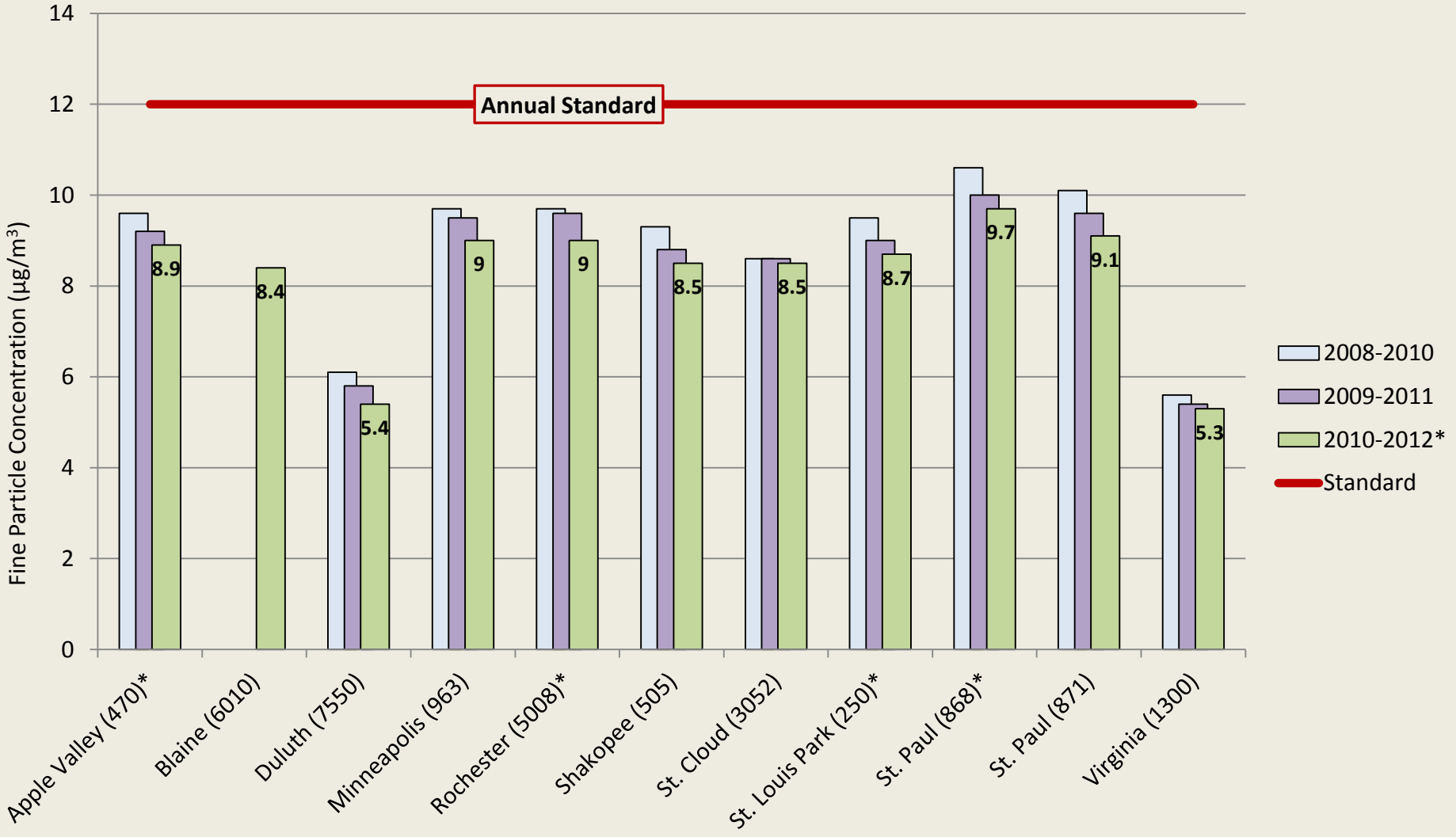
Daily $PM_{2.5}$ Design Values



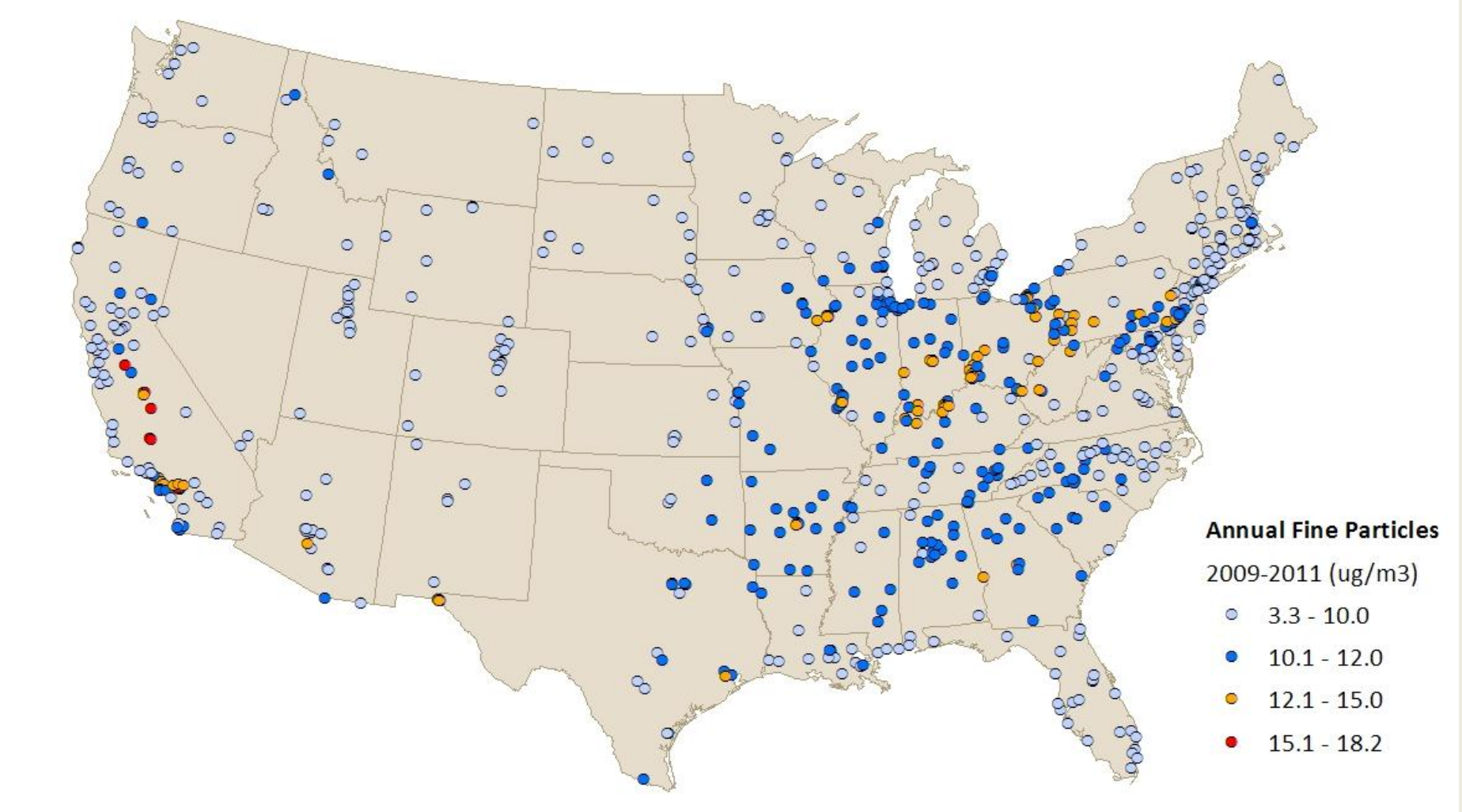
National Daily Fine Particle Concentrations, 2009-2011



Annual $PM_{2.5}$ Design Values



National Annual Fine Particle Concentrations, 2009-2011



Threat of Nonattainment

Causes

- **Strengthened air quality standards**
- Changing weather patterns
- Degradation of air quality

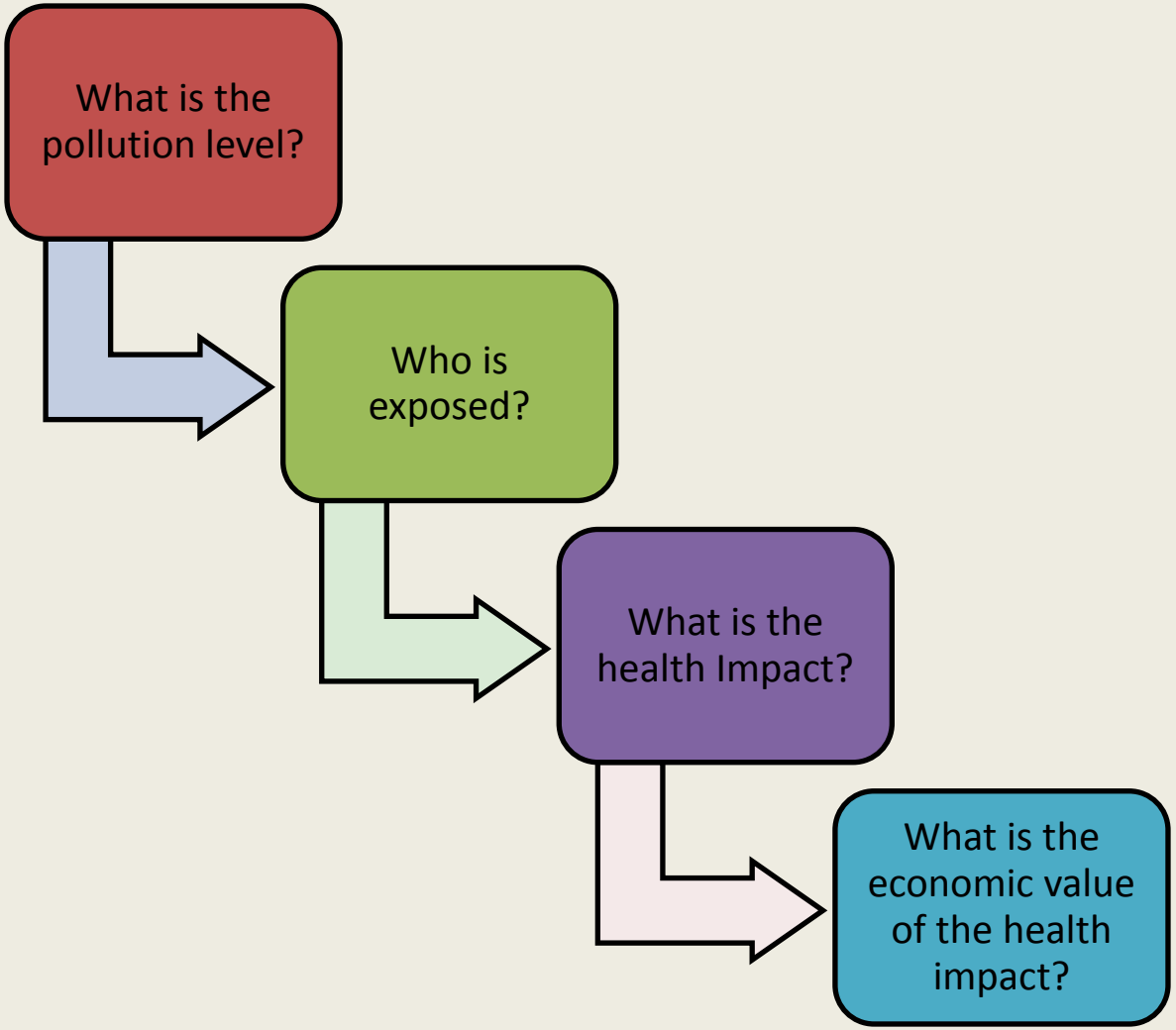
Regulatory Costs

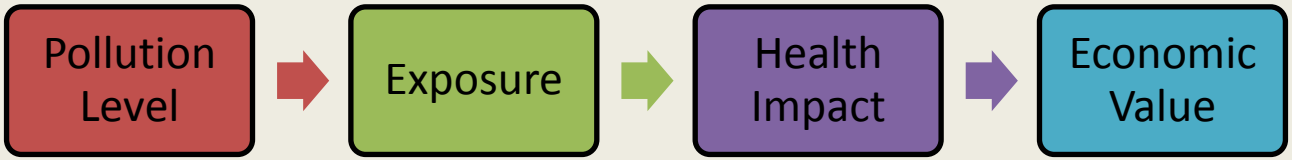
- Requires stricter air permitting, increased monitoring and modeling, and development of a State Implementation Plan
- MN Chamber of Commerce (1999) estimated that meeting nonattainment regulatory requirements would **cost $189-266 million, annually**

Health Costs

- Major health benefits associated with reducing fine particles and ozone
- EPA estimates that the 1990 CAA Amendments will generate **$2 trillion** in annual health benefits by 2020

Estimating Air Pollution Health Costs





David Bael, MPCA

ANALYSIS: PUBLIC HEALTH BURDEN ATTRIBUTABLE TO CURRENT AIR POLLUTION

Analysis Summary

What is the pollution level?

- Pollution Difference = Amount by which the current air pollution levels exceed a specified background pollution level

Who is exposed?

- What is the pollution difference for each person in Minnesota?

What is the health Impact?

- What are the health impacts attributable to the pollution difference?

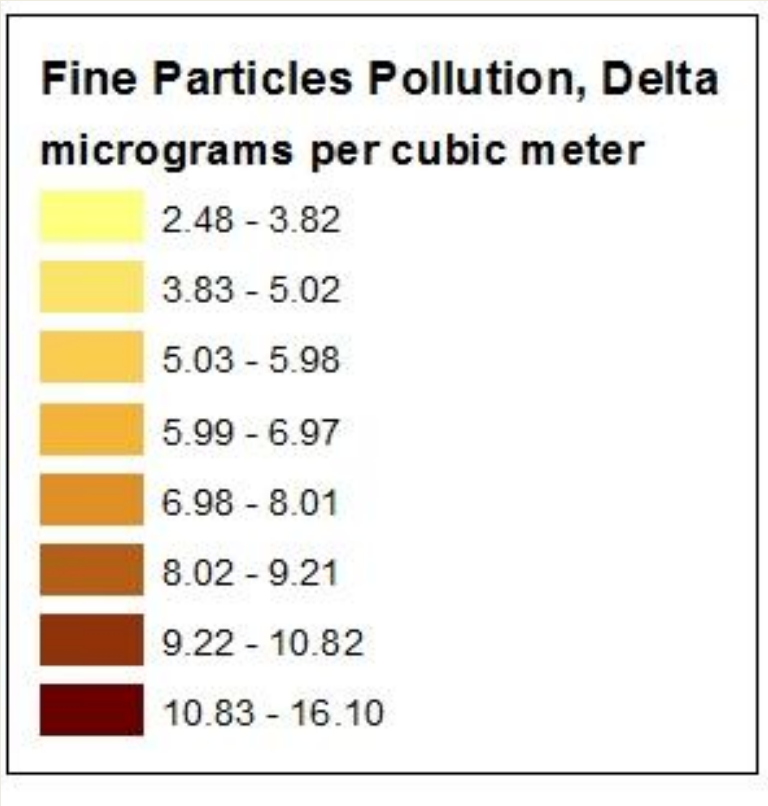
What is the economic value of the health impact?

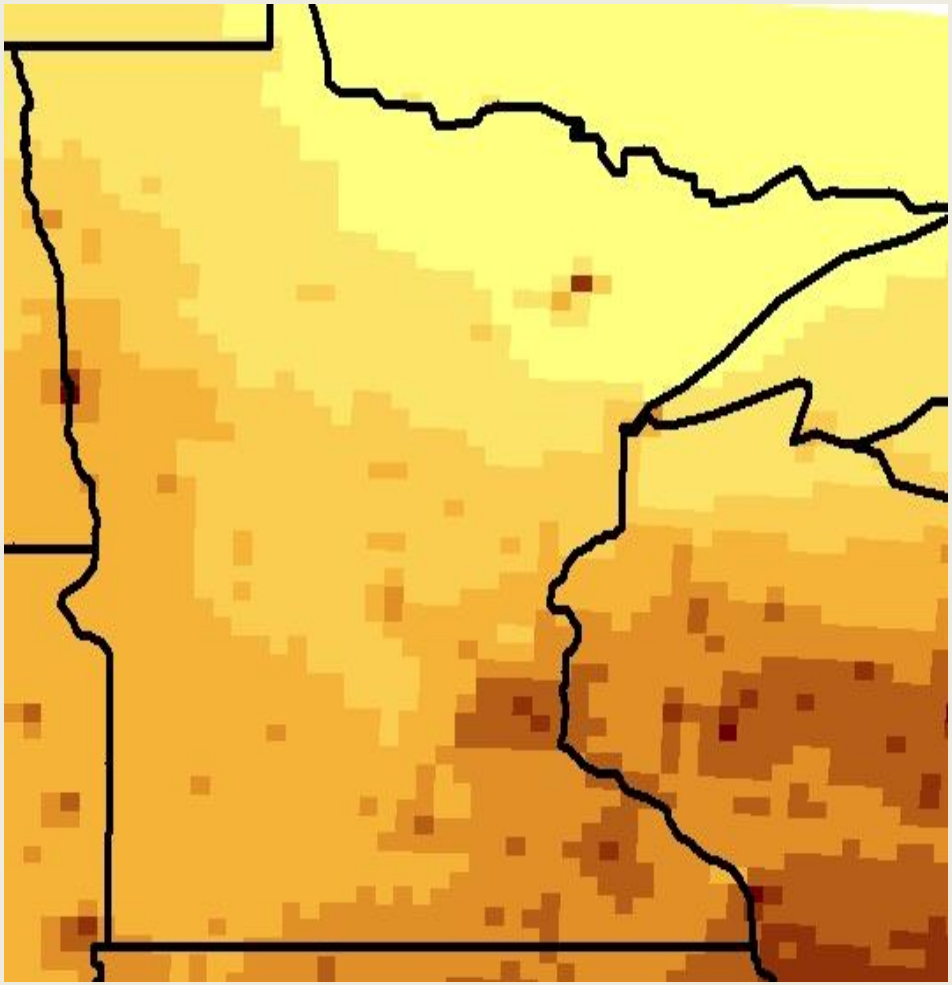
- What are the economic values of those health impacts attributable to the pollution difference?

What Is the Pollution Level?

- Current air quality modeled using:
  - Emissions
  - Ambient monitor data
- Pollution difference between current air quality and
  - "Policy Relevant Background"
    - All North American man-made emissions removed
  - "Minnesota Zero-Out Scenario"
    - All Minnesota emissions removed

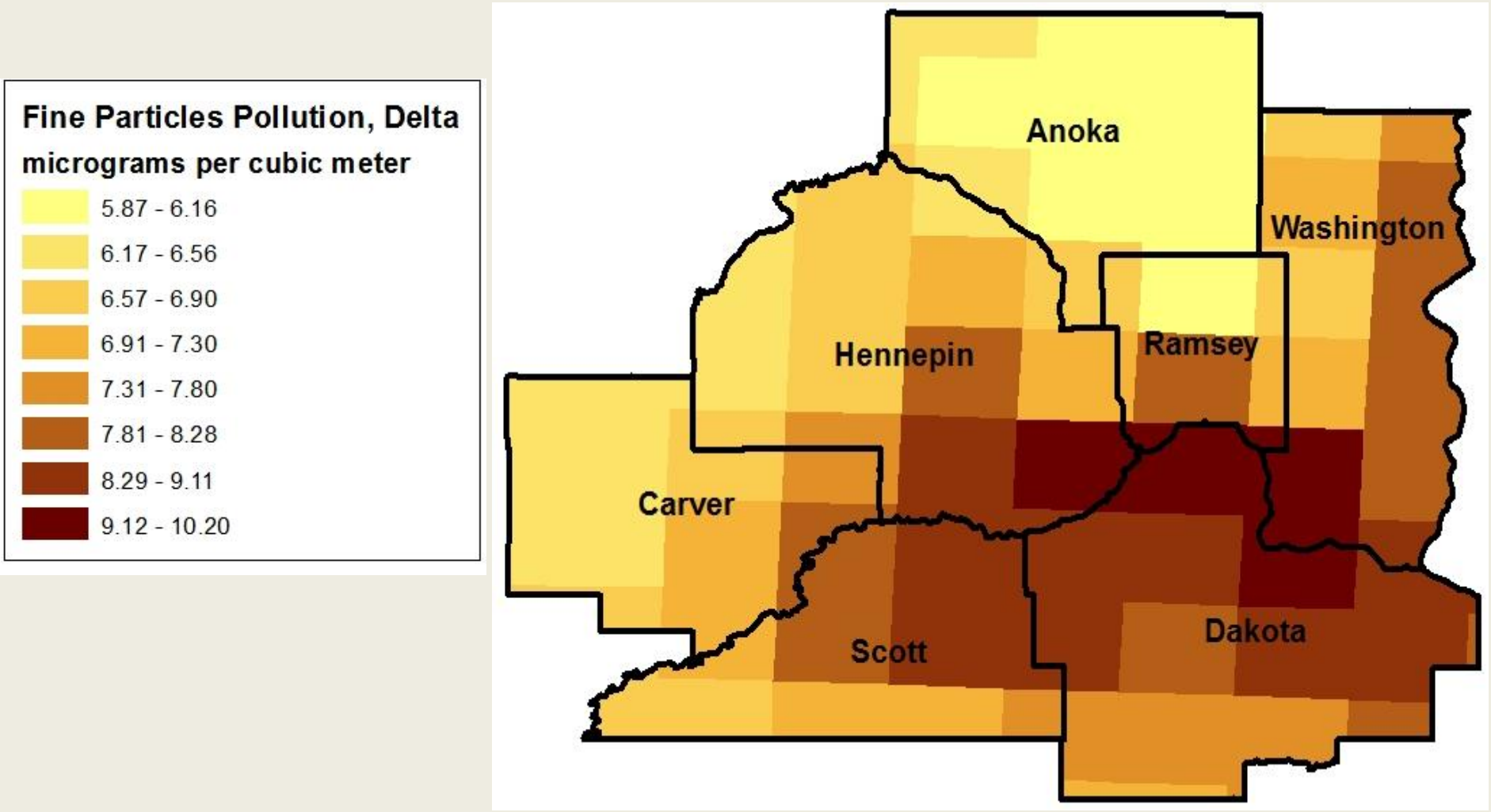
Minnesota $PM_{2.5}$ Pollution: Degree above Background





Pollution Level → Exposure → Health Impact → Economic Value

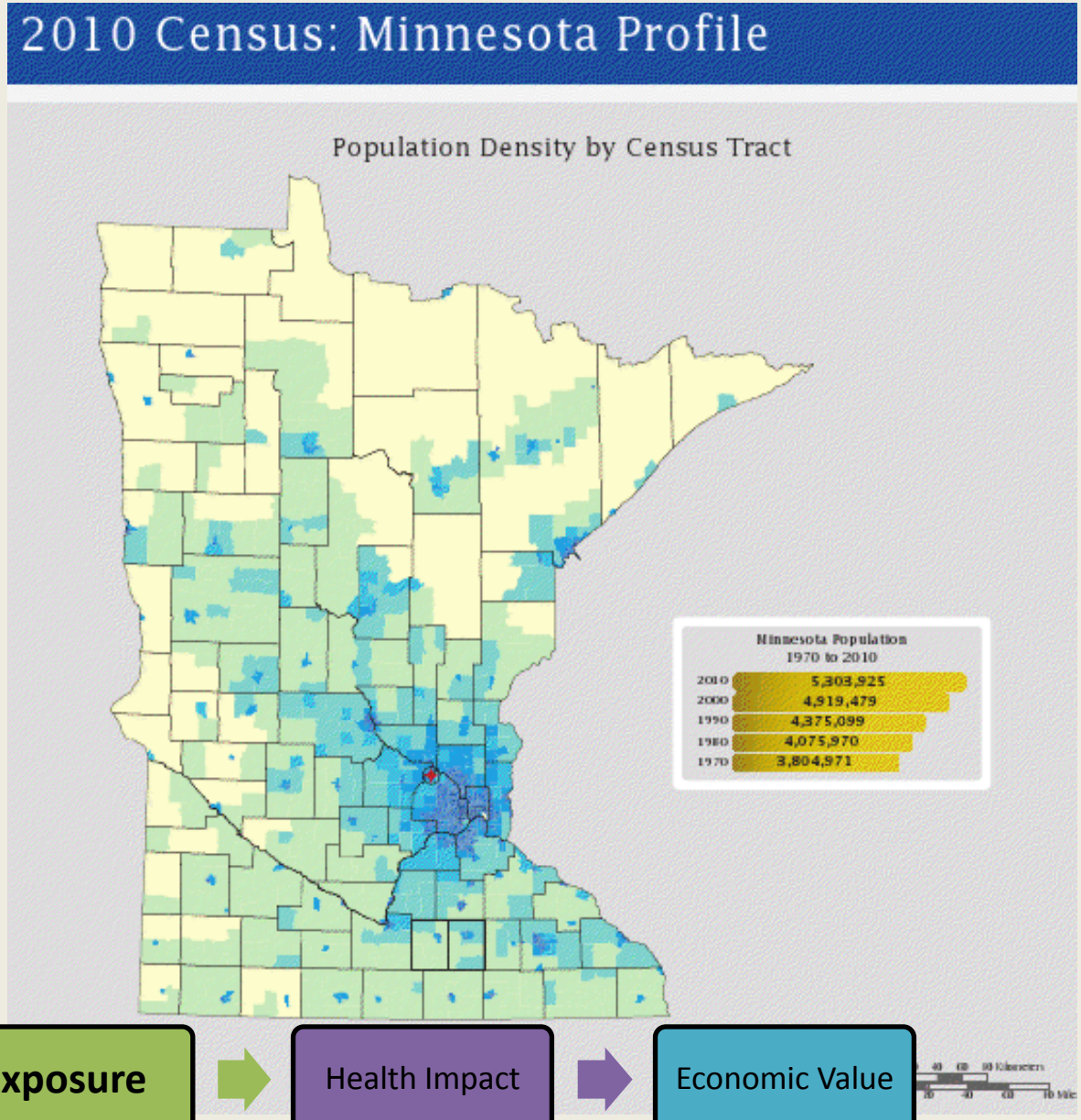
Metro Area $PM_{2.5}$ Pollution: Degree above Background



Pollution Level → Exposure → Health Impact → Economic Value

Who Is Exposed?

Areas of larger population mean more people are exposed to the air pollution.

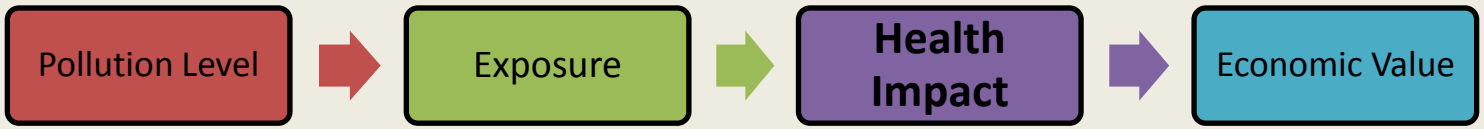


Pollution Level → **Exposure** → Health Impact → Economic Value

What is the Health Impact?

Health Endpoint	$PM_{2.5}$	Ozone
Premature Mortality*	☒	☒
Nonfatal heart attack	☒	
Hospital Admissions	☒	☒
Asthma ER visits	☒	☒
Acute respiratory symptoms	☒	☒
Asthma attacks	☒	☒
Work loss days	☒	
School absence rates		☒

*Long term $PM_{2.5}$-related mortality and short-term O_3-related mortality



Quantifying Health Impacts

- Health impact functions from epidemiological literature:

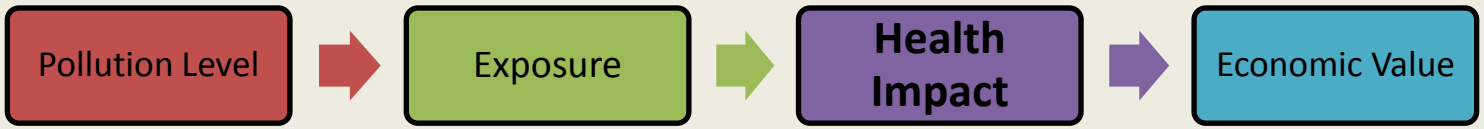
$$\Delta Y = Y_o (1 - e^{-\beta \Delta PM}) * Pop$$

Y_o – Baseline Incidence

ß - Effect estimate

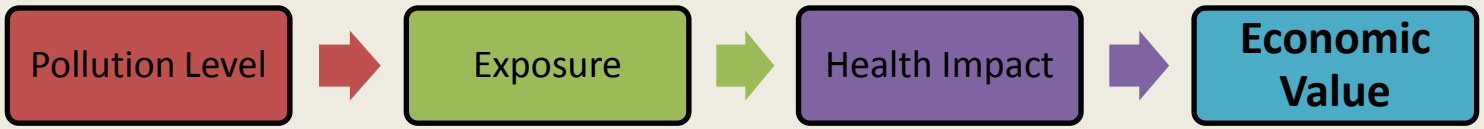
Pop – Exposed population

ΔPM – Air quality change



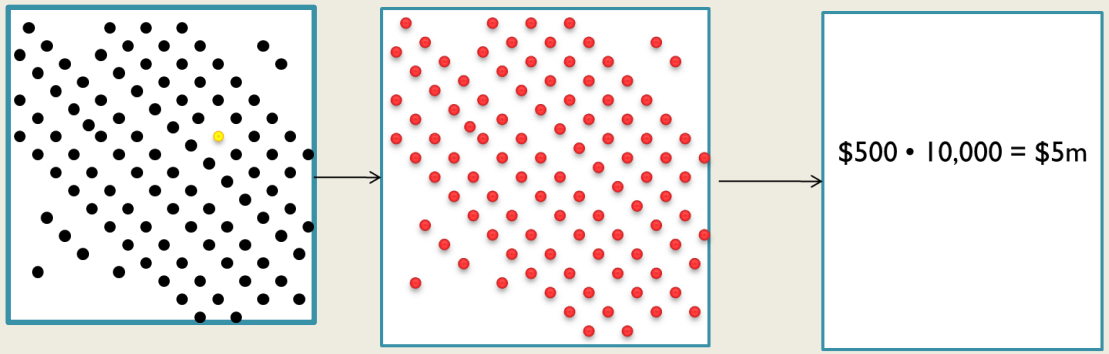
What Is the Economic Value of the Health Impact?

- Cost of Illness
  - Medical expenses for treatment of illness
  - Captures the monetary savings of reducing a health effect
  - Ignores the value of reduced pain and suffering
- Willingness to Pay
  - Captures lost wages, avoided pain and suffering, loss of satisfaction, loss of leisure time, etc.
  - Measures the complete value of avoiding a health outcome
  - Used to estimate value of statistical life saved (for mortality value estimates)



EXAMPLE : Assigning Monetary Value to Premature Mortality Using WTP

- This slide walks through the process of using "Willingness-to-Pay" estimates to derive a economic value of a premature death
  - Hypothetical numbers are used for ease of calculation
- EPA's valuation estimates are based on multiple studies



In a hypothetical population of 10,000, reducing pollution would avoid one premature death, or reduce the risk of by 1 / 10,000

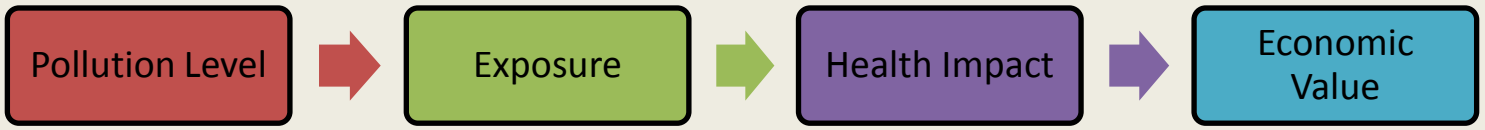
In this population, imagine survey results show that, on average, they are willing to pay $500 each for this level of risk reduction

In this example, the total value of an avoided death is the average "Willingness to Pay" multiplied by the inverse of the risk reduction

Pollution Level → Exposure → Health Impact → **Economic Value**

An Illustrative Example: $PM_{2.5}$

- Statewide Premature Mortality from Fine Particles Pollution
  - Pollution removed by eliminating North American man-made emissions ranges from 2.5 – 16 µg/m^3 across the state
  - Annual deaths avoided from this change ≈ 3,800
  - Value of avoided death based on Willingness to Pay studies ≈ $8.9 million
  - Total value of health impact = 3,800 x $8.9 million ≈ $34 billion



Annual Health Impact Estimates
Statewide $PM_{2.5}$

Health Impact	Impact of All Anthropogenic Air Pollution		Impact of Minnesota Emissions	
	Incidences	*Value*	*Incidences*	*Value*
Adult Mortality	3,800	$34 billion	1,600	$14 billion
Infant Mortality	3	$30 million	1	$13 million
Respiratory Hospital Admissions	420	$10 million	170	$4.2 million
Cardiovascular Hospital Admissions	520	$17 million	210	$7.2 million
Acute Respiratory Symptoms	1.5 million	$96 million	660,000	$41 million
Lower Respiratory Symptoms	38,000	$730,000	16,000	$320,000
Upper Respiratory Symptoms	57,000	$1.8 million	24,000	$740,000
Work Loss Days	260,000	$39 million	110,000	$17 million
Asthma Exacerbation	140,000	$7.4 million	58,000	$3.1 million
Respiratory Emergency Room Visits	770	$290,000	330	$120,000
Acute Bronchitis	2,900	$1.3 million	1,300	$560,000
Non-Fatal Heart Attacks	1,600	$170 million	710	$75 million

Annual Health Impact Estimates Metro Area $PM_{2.5}$

Health Impact	Impact of All Anthropogenic Air Pollution		Impact of Minnesota Emissions	
	Incidences	*Value*	*Incidences*	*Value*
Adult Mortality	2,100	$18 billion	1,000	$9.1 billion
Infant Mortality	2	$19 million	1	$9.4 million
Respiratory Hospital Admissions	230	$5.6 million	110	$2.7 million
Cardiovascular Hospital Admissions	290	$9.7 million	140	$4.7 millio
Acute Respiratory Symptoms	930,000	$59 million	60,000	$29 million
Lower Respiratory Symptoms	22,000	$430,000	11,000	$210,000
Upper Respiratory Symptoms	34,000	$1.0 million	16,000	$490,000
Work Loss Days	160,000	$28 million	78,000	$13 million
Asthma Exacerbation	81,000	$4.3 million	39,000	$2.1 million
Respiratory Emergency Room Visits	460	$170,000	220	$83,000
Acute Bronchitis	1,700	$750,000	840	$370,000
Non-Fatal Heart Attacks	910	$97 million	460	$49 million

Another Example: Ozone

- Statewide Acute Respiratory Symptoms from Ozone Pollution
  - Pollution removed from eliminating all man-made emissions ranges from 0 – 22 parts per billion across the state
  - Annual incidents of acute respiratory symptoms avoided from this change ≈ 380,000
  - Cost of an incident of acute respiratory symptoms based on Cost of Illness studies ≈ $60
  - Total value of health impact = 380,000 x $60 ≈ $22 million

Annual Health Impact Estimates Statewide Ozone

Health Impact	Impact of all Anthropogenic Air Pollution		Impact of Minnesota Emissions	
	Incidences	*Value*	*Incidences*	*Value*
Adult Mortality	61	$450 million	15	$110 million
Respiratory Hospital Admissions	440	$8.7 million	110	$2.2 million
Acute Respiratory Symptoms	380,000	$22 million	96,000	$5.7 million
School Loss Days	140,000	$12 million	36,000	$3.2 million
Respiratory Emergency Room Visits	150	$57,000	39	$14,000

Annual Health Impact Estimates,Metro Area Ozone

Health Impact	Impact of all Anthropogenic Air Pollution		Impact of Minnesota Emissions	
	Incidences	*Value*	*Incidences*	*Value*
Adult Mortality	29	$210 million	2	$13 million
Respiratory Hospital Admissions	210	$4.2 million	15	$280,000
Acute Respiratory Symptoms	200,000	$12 million	16,000	$970,000
School Loss Days	73,000	$6.5 million	6,500	$580,000
Respiratory Emergency Room Visits	82	$30,000	7	$2,600

Conclusions

- Minnesota's total health burden attributable to $PM_{2.5}$ and ozone from man-made pollution is substantial
  - Fine particles, in particular, have a considerable health impact statewide and in the Twin Cities metro area
  - The economic consequences are driven by the value of avoided deaths
- Reducing pollution will improve the health of Minnesotans
  - Will require taking a look at all our sources of pollution

Mark Lundgren, Scott Strand, and Mike Hansel

MINNESOTA'S CLEAN AIR DIALOGUE

Minnesota's Clean Air Dialogue

- Goal
  - Conversation among a wide range of impacted parties
    - Business, Government, Non-profit
  - Collaboratively address the emerging air quality challenge
- Process
  - Identify challenges associated with air pollution and nonattainment
  - Identify opportunities to improve air quality
  - Develop strategies to implement identified action

Technical Working Groups

- Some traditional categories
  - Point Sources
  - Heavy Duty Diesel
  - Area Sources
- Some less traditional categories
  - Energy Efficiency and Renewable Energy
  - Residential wood burning
  - Light duty vehicles and transportation demand management

Outcome: Recommendations

- Strategies for each source category
- Three main categories of strategies:
  - Education and outreach
  - Incentives
  - Regulation
- Strategies along multiple time scales
- The partnerships developed are a key mechanism for strategy implementation
  - Use existing channels/relationships for sharing information

Collaborative History and Quantifiable Outcomes

- Clean Air Minnesota
- Project Green Fleet
  - > 3200 school buses
    - Equal to 350,000 cars removed from road (for PM pollution)
  - > 300,000 students have cleaner rides and reduced exposure
  - Leveraged State $2.4M (for school buses) with $7.1M in private and federal sources (for all of PGF)

Photo courtesy of Blue Cross and Blue Shield Foundation of MN

Partnerships

- Not the usual suspects
- Why we are involved
- Dialogue recommendations and potential future projects