Detroit Multi-pollutant Pilot Project: NACAA’s Spring 2009 Membership Meeting

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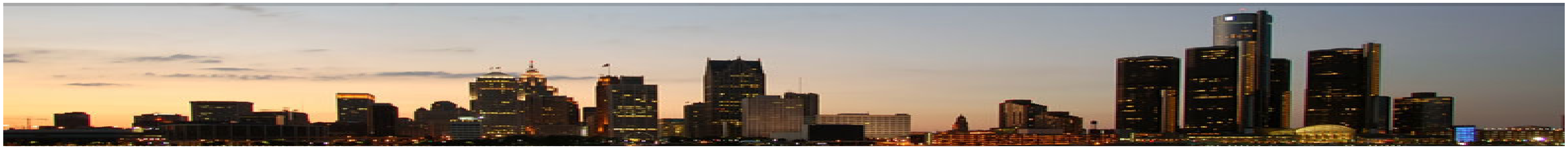
Assistance from outside OAQPS includes MDEQ, SEMCOG, LADCO, OTAQ, CAMD, & ORD.



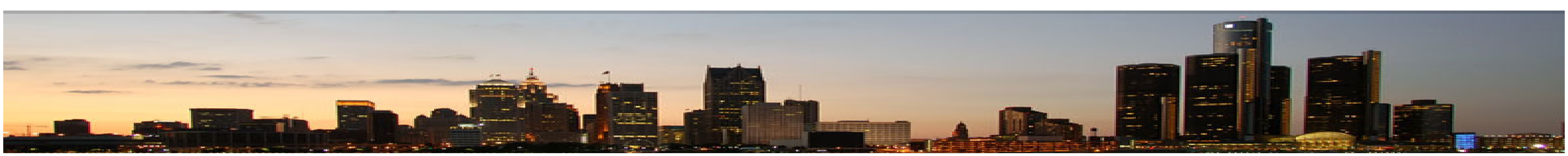
Detroit Multi-pollutant Pilot Project: Overview

- NRC report recommended "Air Quality Management in the United States (2004)":
  - … that the United States ***transition from a pollutant-by-pollutant approach to air quality management to a multi-pollutant, risk-based approach . . .***

- In response, EPA is investigating the application our technical tools/methods in a multi-pollutant, risk-based approach to control strategy development.

  → We selected the Detroit urban area as a testbed to apply and evaluate MP tools & compare a MP-based control strategy to a SIP-based control strategy.

  Goal: To get reductions at the monitors for $PM_{2.5}$ *&* O_3 *to meet the current standards, AND also reduce* $PM_{2.5}$, O_3 *& HAP exposure across domain, especially in densely populated areas.*

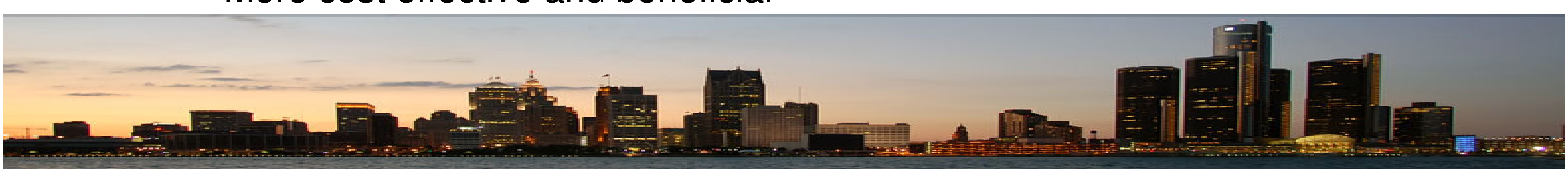


Detroit Multi-pollutant Pilot Project: Highlights

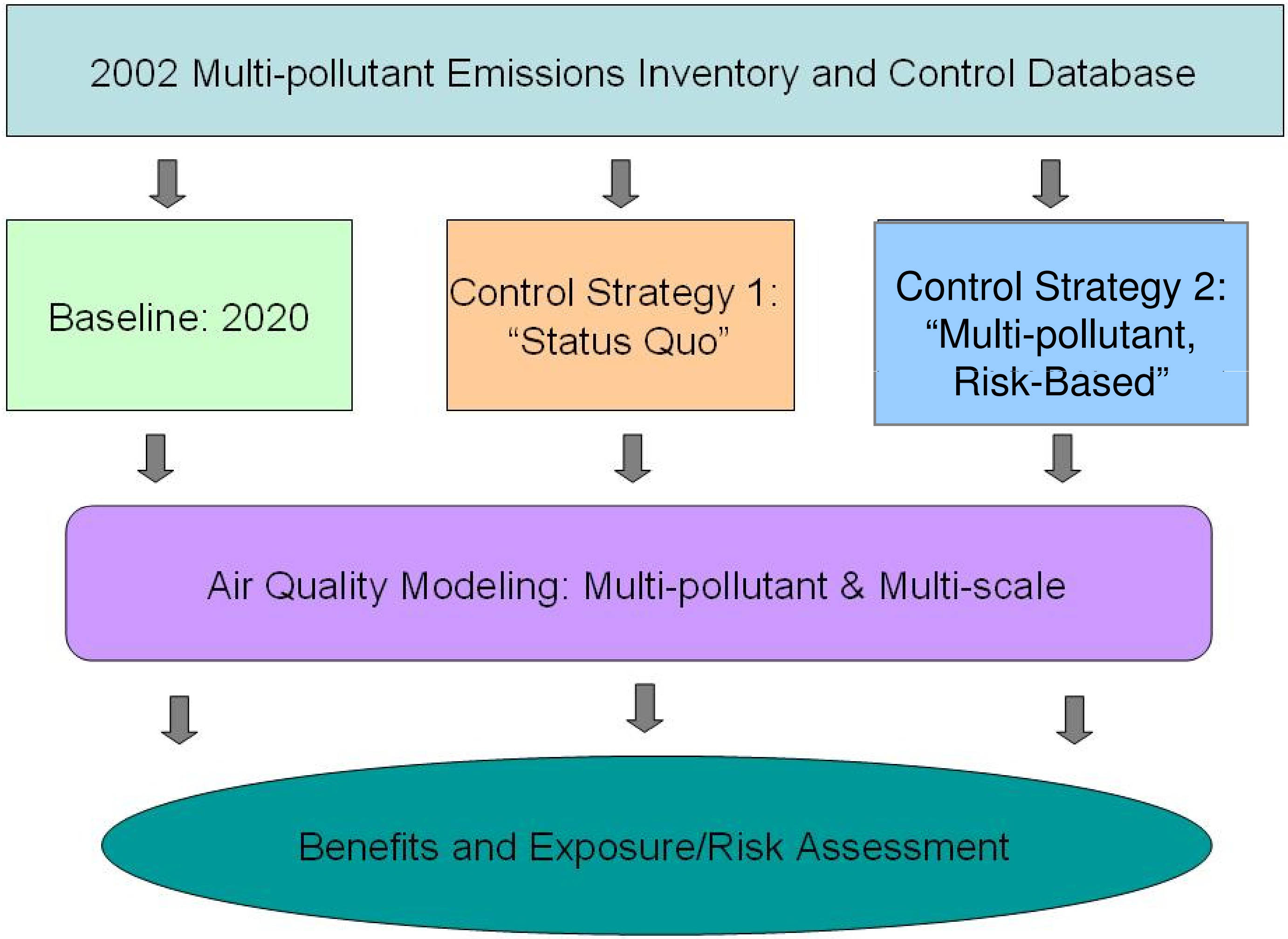
- This project is our 1st assessment of a Multi-Pollutant, Risk-Based approach to developing control strategies and comparison to a SIP-based approach.

- Showed the value of . . .
  - Developing a MP modeling platform for the Detroit urban area; and
  - Understanding the MP nature of air quality issues in this area through formal development of a “Conceptual Model”
  - Collecting local-scale information including emissions, AQ modeling, control and health data

- Demonstrated that our “Multi-pollutant, Risk-Based” (MPRB) Control Strategy achieved:
  - Same or greater reductions of $PM_{2.5}$ & O_3 at monitors
  - Improved air quality regionally and across urban core for O_3, $PM_{2.5}$, and selected air toxics
  - Approximately 2x greater benefits for $PM_{2.5}$ & O_3
  - Reduction in non-cancer risk
  - More cost effective and beneficial

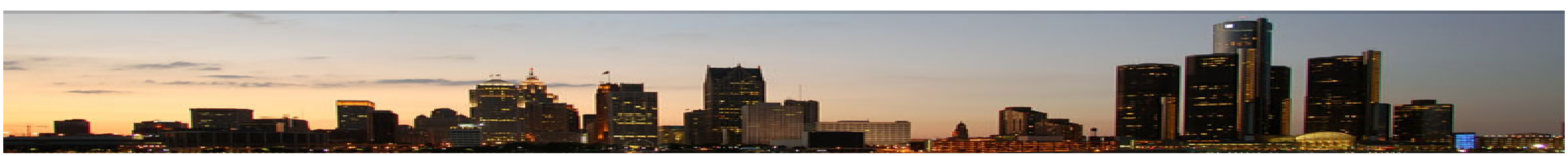


Control Strategy Development & Assessment Overview



Control Strategy 1: "Status Quo"

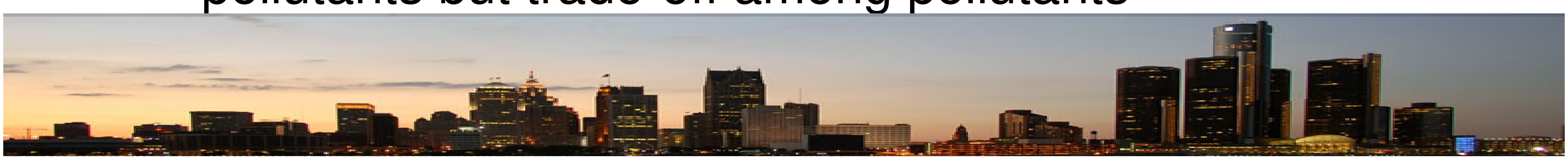
- "Status Quo" because controls were selected to achieve separate O_3 and $PM_{2.5}$ attainment goals based on least-cost criteria
  - $PM_{2.5}$ Controls from EPA $PM_{2.5}$ NAAQS RIA 15/35
  - O_3 Controls from MDEQ Draft O_3 SIP Strategy Plan for 85 ppb NAAQS
- However, controls were "multi-pollutanized" so that air toxics and other criteria pollutant changes were quantified and modeled
  - Not a trivial task and required collaboration from across Office (e.g., SPPD engineers for specific sectors)
  - Need continued focus and efforts in this area as critical for future multi-pollutant work



"Multi-pollutant, Risk-Based" Control Strategy: Selection Criteria

Goal: To get at least the same reductions as "Status Quo" for $PM_{2.5}$ *&* O_3 *at the monitors, and also reduce* $PM_{2.5}$*,* O_3 *& HAP exposure throughout the region, with particular focus on densely populated areas.*

1. Meet or exceed AQ improvements at monitors
2. Population oriented reductions to more broadly improve AQ throughout the region & decrease risk/exposure
3. Maximize co-control potential, especially for air toxics
4. Find more cost-effective reductions (\$ per $\mu g/m^3$ & ppb)
5. Keep similar total reductions for primary controlled pollutants but trade-off among pollutants

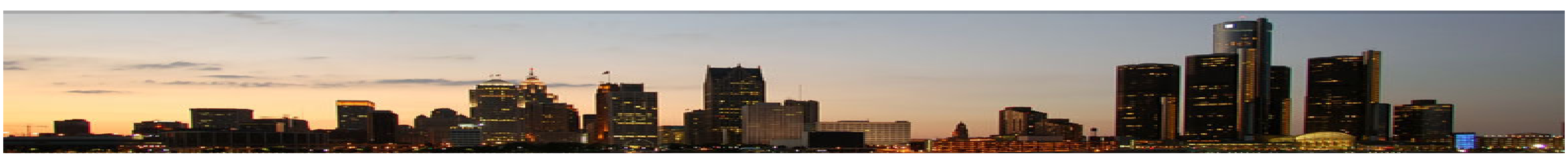


Process to develop "Multi-pollutant, Risk-Based" control strategy

- Determine controls to "keep" from "Status Quo"
  - Because they meet our selection criteria
- Determine those controls from "Status Quo" to "trade-off" for new controls that better meet selection criteria
  - PM controls

    → Can we "trade-off" for more direct $PM_{2.5}$ controls, closer to densely populated areas & monitors & with co-benefit opportunities?
  - VOC controls

    → Can we "trade-off" for more population oriented VOC reductions closer to the urban core (without encountering O_3 dis-benefits) and get co-benefit reductions?



Example of MP Control Effectiveness

- EGU: Coal Washing

SO_2	$PM_{2.5}$	PM_{10}	Metal HAPS
35%	35%	45%	25-75%

- Autobody refinishing: Education & Training

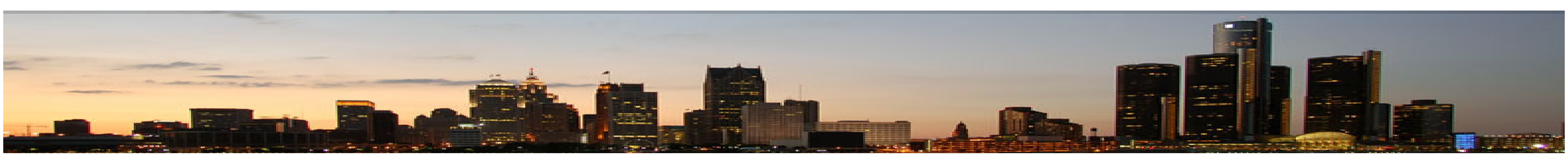
Inorganic HAPS	Organic HAPS/VOC	PM_{10} & $PM_{2.5}$
92.0%	18.6%	92.0%

- Mobile Controls: Diesel Retrofits (Example Reductions)

$PM_{2.5}$	VOC	CO	Diesel PM
7.5%	0.5%	0.12%	13.7%

- Residential Wood Combustion: Education & Advisory

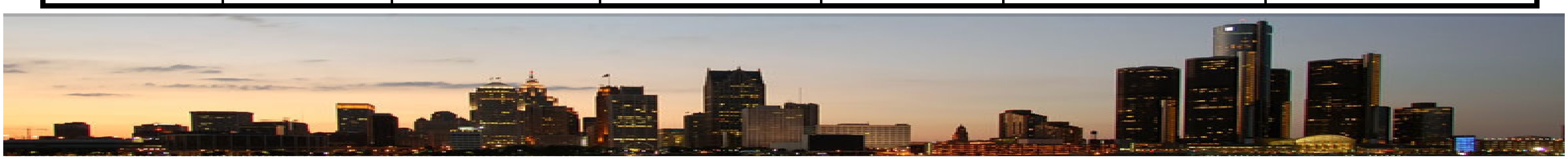
$PM_{2.5}$	SO_2	VOC	NO_x	CO
50%	50%	50%	50%	50%



"Status Quo" vs. "Multi-pollutant, Risk-Based": Criteria Pollutant Emissions Changes

- Traded SO_2 reductions for direct $PM_{2.5}$ reductions
- Also controlled slightly more tons VOC
- NO_x and CO reductions (& air toxics) were co-benefit pollutant reductions

Pollutant	2020 Base (tons)	"Status Quo"		"MP, Risk-Based"		Total tons Difference
		Tons Reduced	% Change from Base	Tons Reduced	% Change from Base	
$PM_{2.5}$	31,485	1,747	6%	3,183	10%	+ 1,436
SO_2	187,525	10,297	5%	2,429	1%	- 7,868
VOC	104,872	5,814	6%	8,623	8%	+ 2,808
NO_x	118,432	31	0.03%	2,016	2%	+ 1,985
CO	424,426	1546	0.4%	64,187	15%	+ 62,641

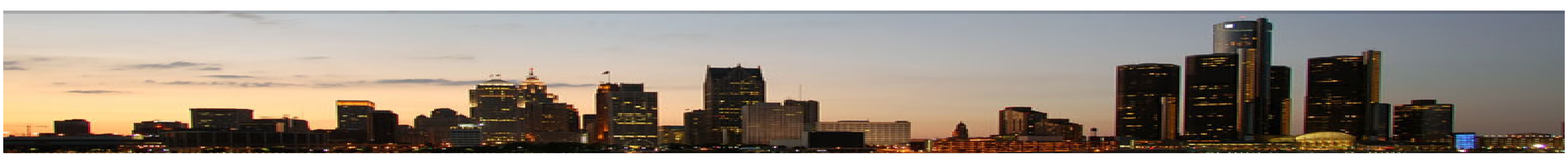


"Status Quo" vs. "Multi-pollutant, Risk-Based": Toxic Pollutant Emissions Changes

Pollutant	"Status Quo" Reductions (tons)	"MP, Risk-Based" Reductions (tons)	Total Tons Difference
Acetaldehyde	18.35	38.72	+ 20.38
Benzene	130.25	138.73	+ 8.84
1,3-Butadiene	41.52	13.19	- 28.33
1,4-Dichlorobenzene	15.28	15.28	No Change
Formaldehyde	19.16	44.50	+ 25.34
Methylene Chloride	1.63	0	- 1.63
Naphthalene	16.74	4.24	- 12.50
Manganese	0.86	8.50	+ 7.64
Cadmium	9x10-4	2x10-4	- 7x10-4
Nickel	0.19	0.05	- 0.14
Diesel PM	0	30.70	+ 30.70

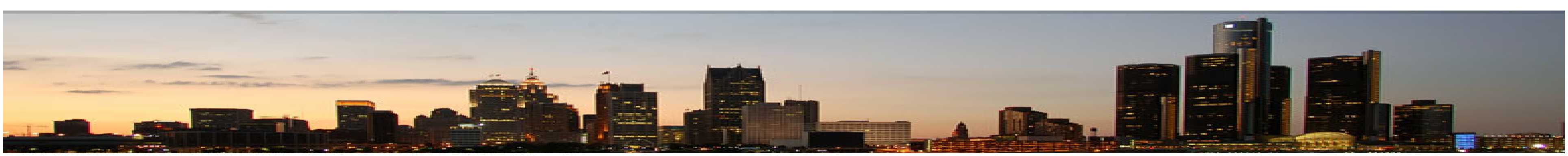
MPRB > Reductions

SQ > Reductions

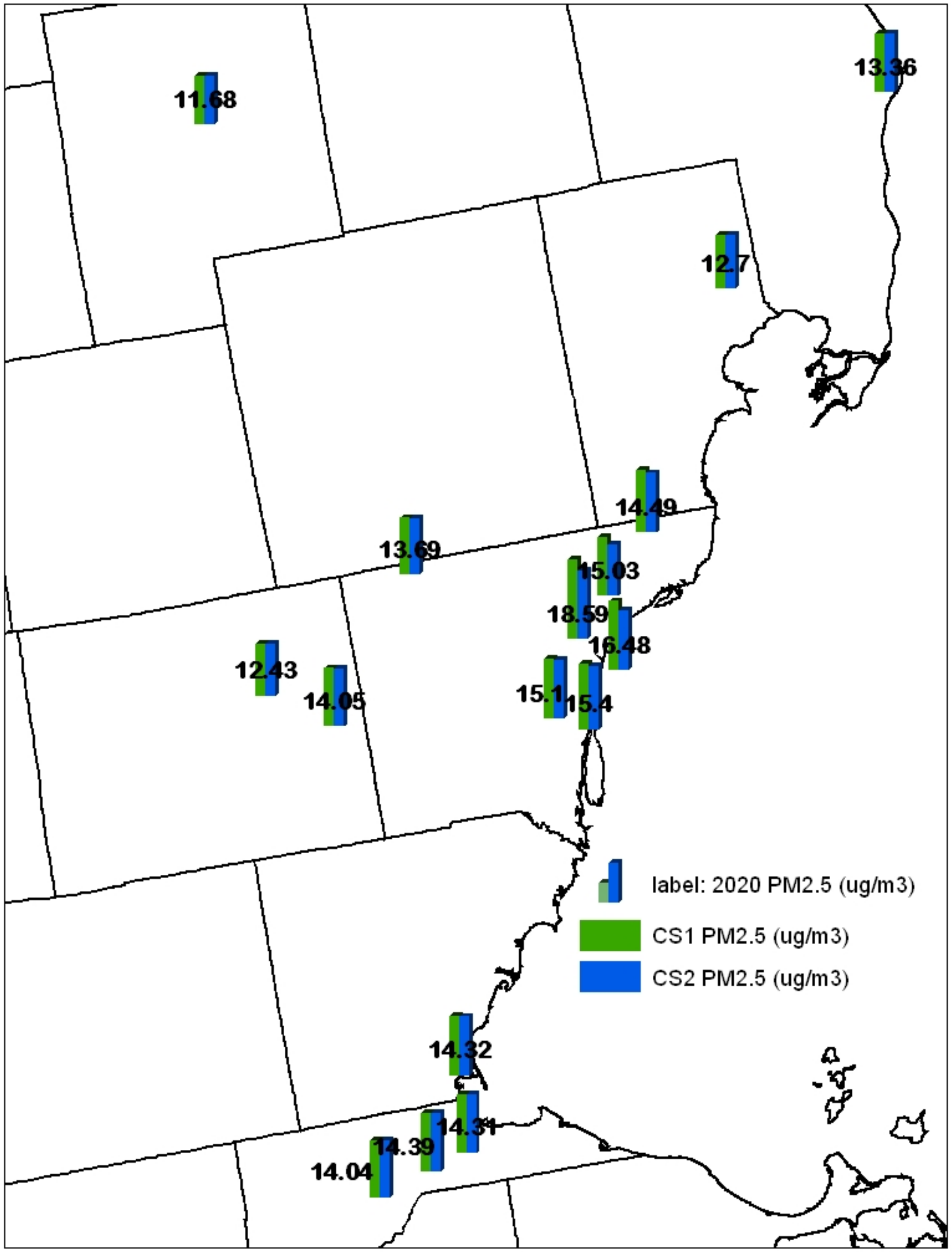


Criteria for "Success"

- Improved O_3 & $PM_{2.5}$ air quality at monitors
  - Compare total reduction at monitors for "Status Quo" vs "MP, Risk-Based"
  - Focus on differences at projected non-attainment monitors
- Improved air quality regionally and across urban core
  - O_3, $PM_{2.5}$, and selected air toxics
- Greater benefits: $PM_{2.5}$ & O_3
  - Population weighted air quality change
  - Monetized benefits
- Reduction in total cancer and non-cancer risk
  - Cancer
    - Max individual risk below 100 in a million
    - Minimizing total incidence
  - Non-cancer
    - Max hazard index (HI) below 1
    - Minimizing people above HI of 1
- Greater net benefits and cost effectiveness for overall strategy



Criteria 1:
Improved O_3 & $PM_{2.5}$
Air Quality at Monitors

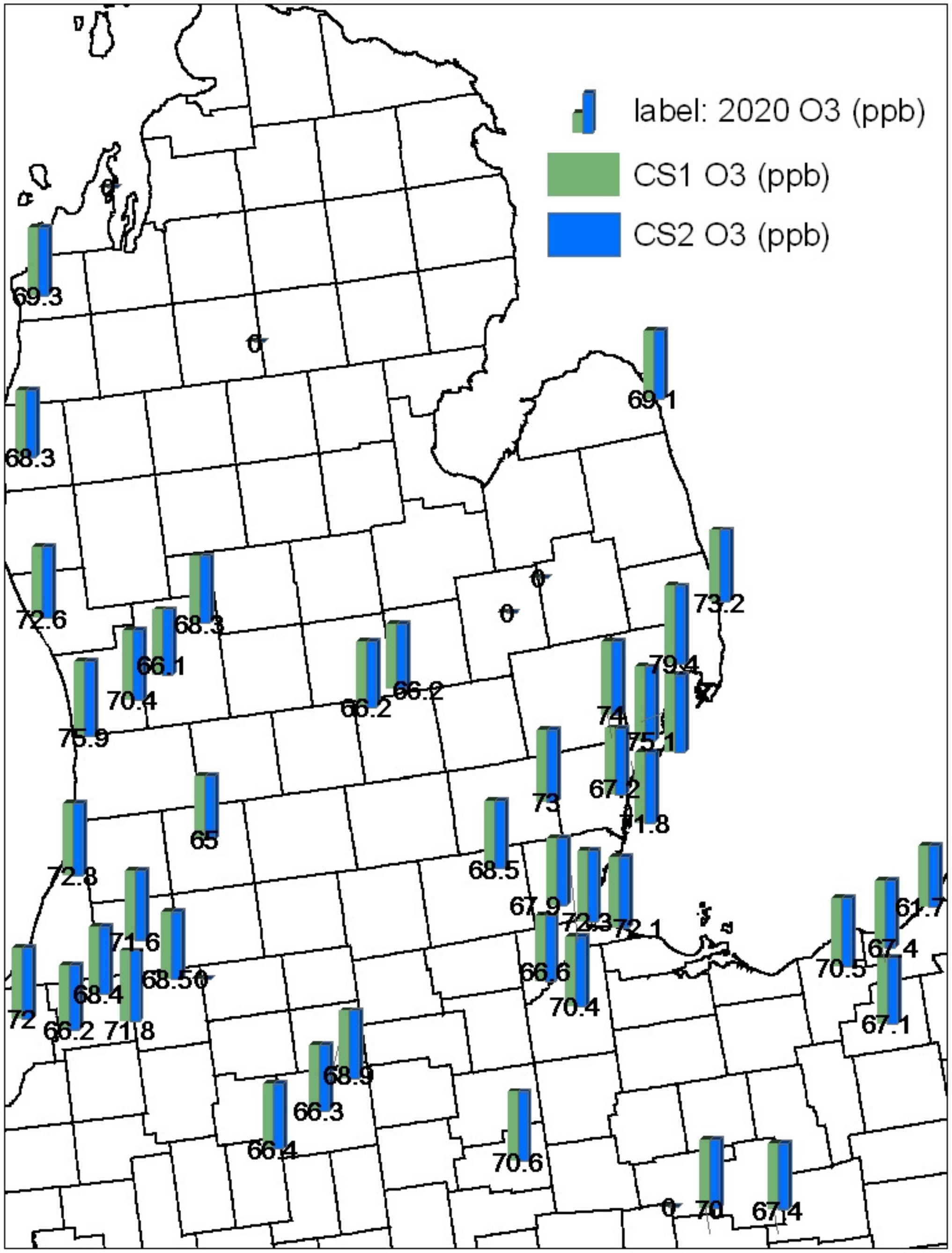


$PM_{2.5}$ Design Values for the Annual Standard for 2020 & 2 Control Strategies

- All projected "MP, Risk-Based" $PM_{2.5}$ Annual Design Values are lower than those from "Status Quo".
- "MP, Risk-Based" brings all monitors below 15 µg/m3 (including Dearborn)

Projected Non-attainment Monitors

Annual $PM_{2.5}$ Design Values (µg/m3)	***2020***	***SQ***	***MP, RB***
Dearborn	18.6	15.6	13.3
N. Delray	16.4	13.6	11.8
Wyandotte	15.4	12.9	12.3



O_3 Design Values for the 8-hr Standard for 2020 & 2 Control Strategies

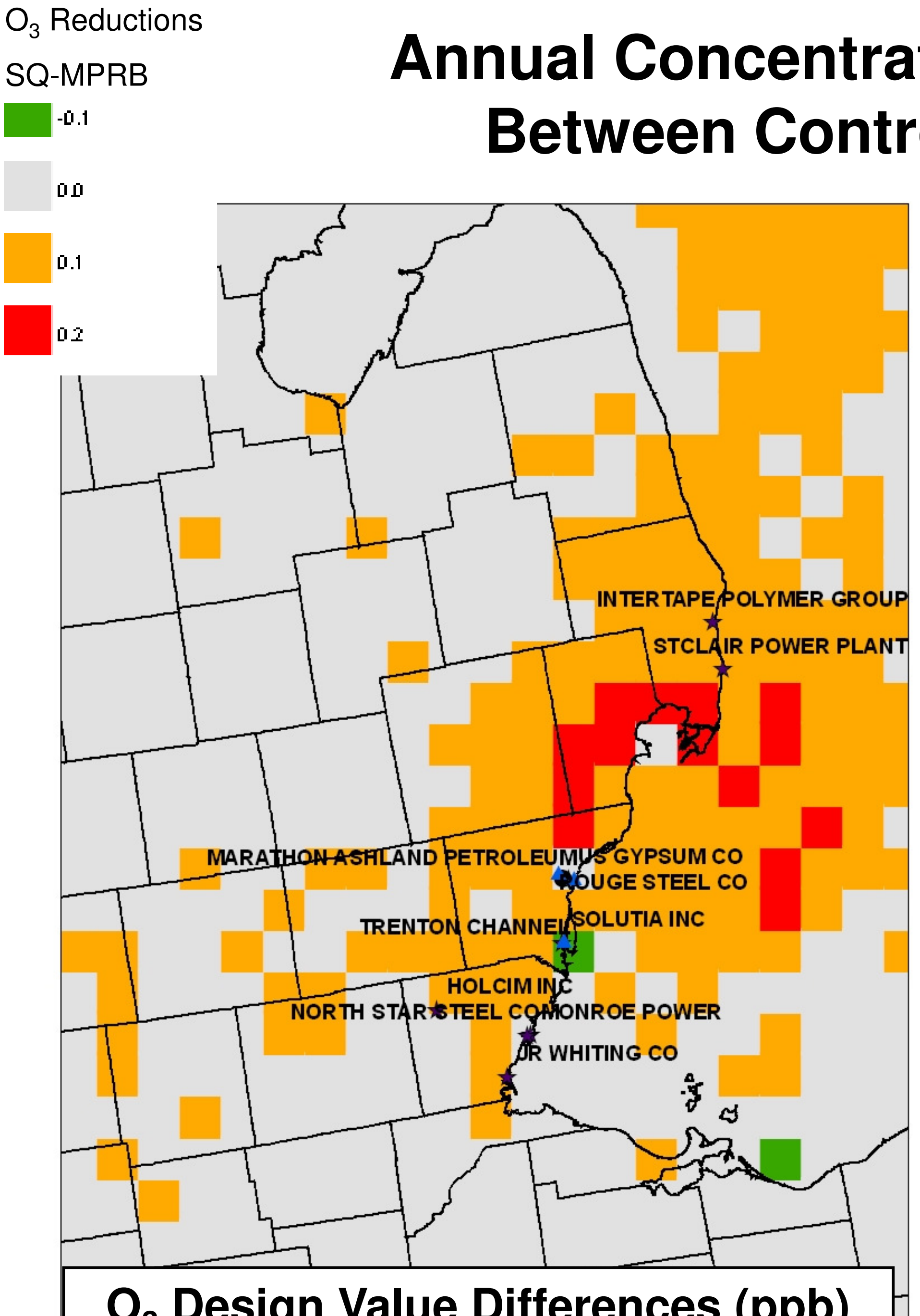
- Small reductions at monitors for either control strategy. All monitors under 85 ppb in 2020.
- “MP, Risk-Based” reductions are always equal or greater than “Status Quo”

O_3 Monitors in Detroit Area

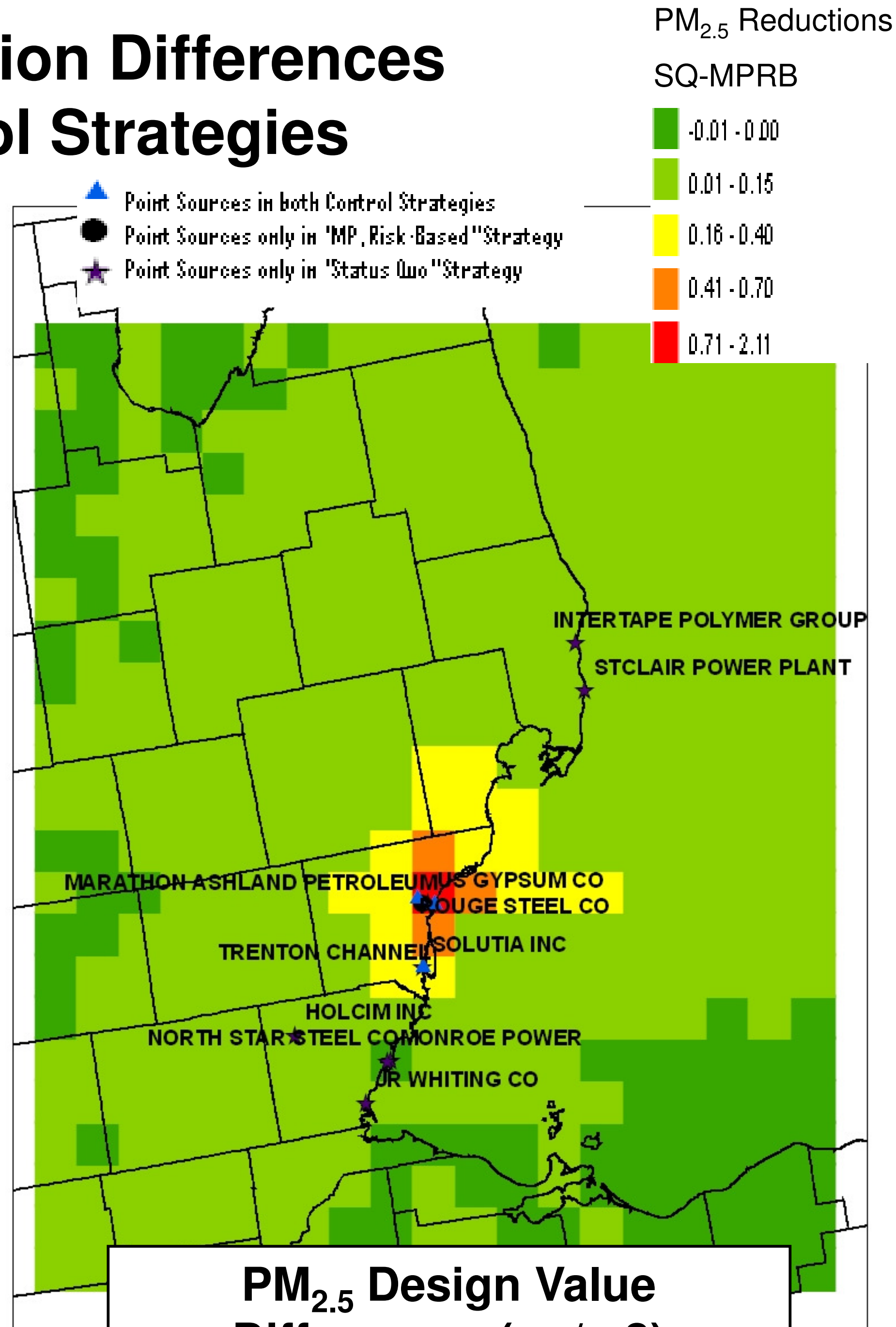
Max 8-hr O_3 Design Values (ppb)	***2020***	***SQ***	***MP, RB***
260991003 Macomb	78.7	78.6	78.4
261610008 Washtenaw	73.0	72.9	72.8
261630016 Wayne	71.8	71.7	71.6

Criteria 2:
Air Quality Improvements
Across Region
& in Urban Core

Annual Concentration Differences Between Control Strategies

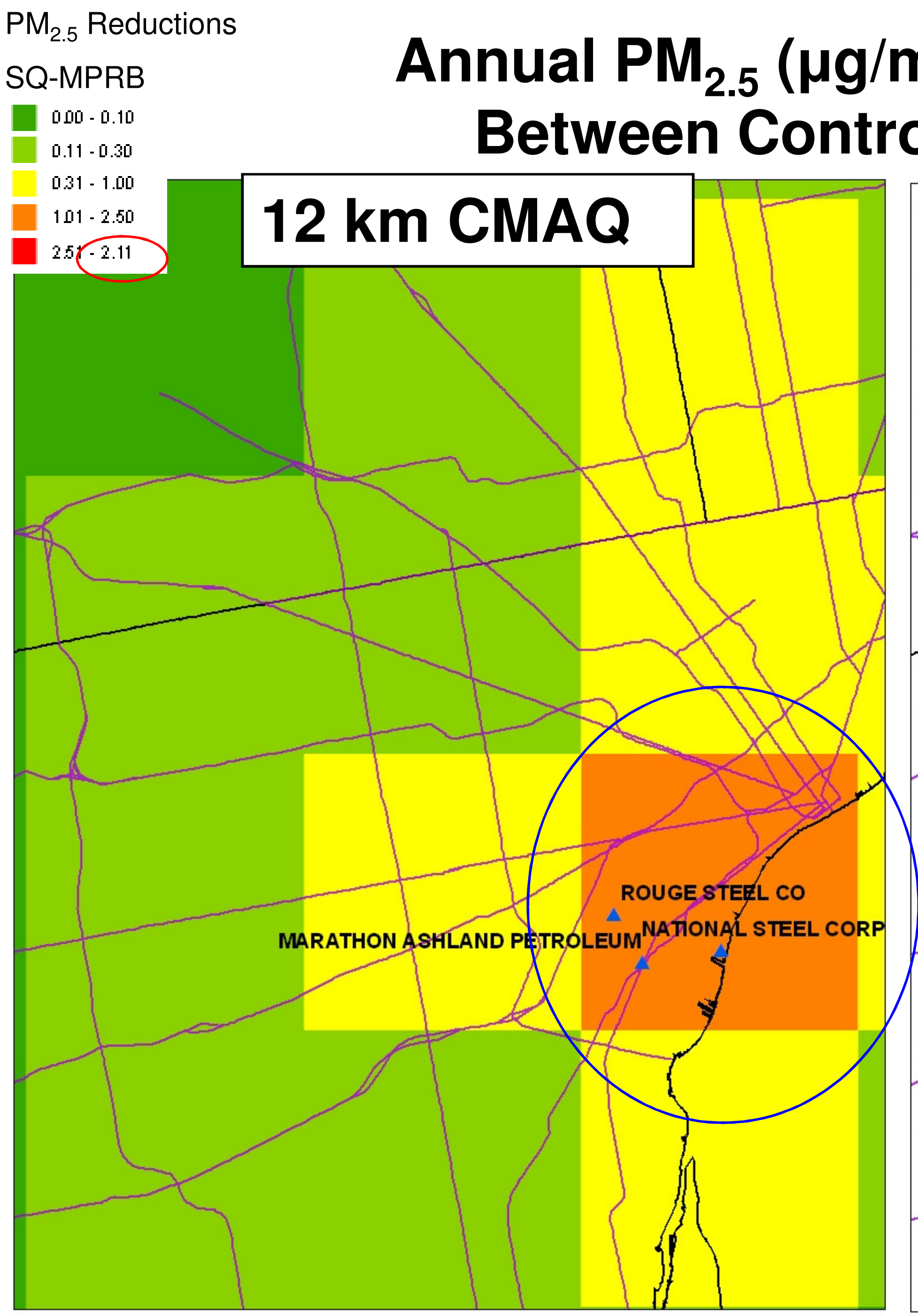


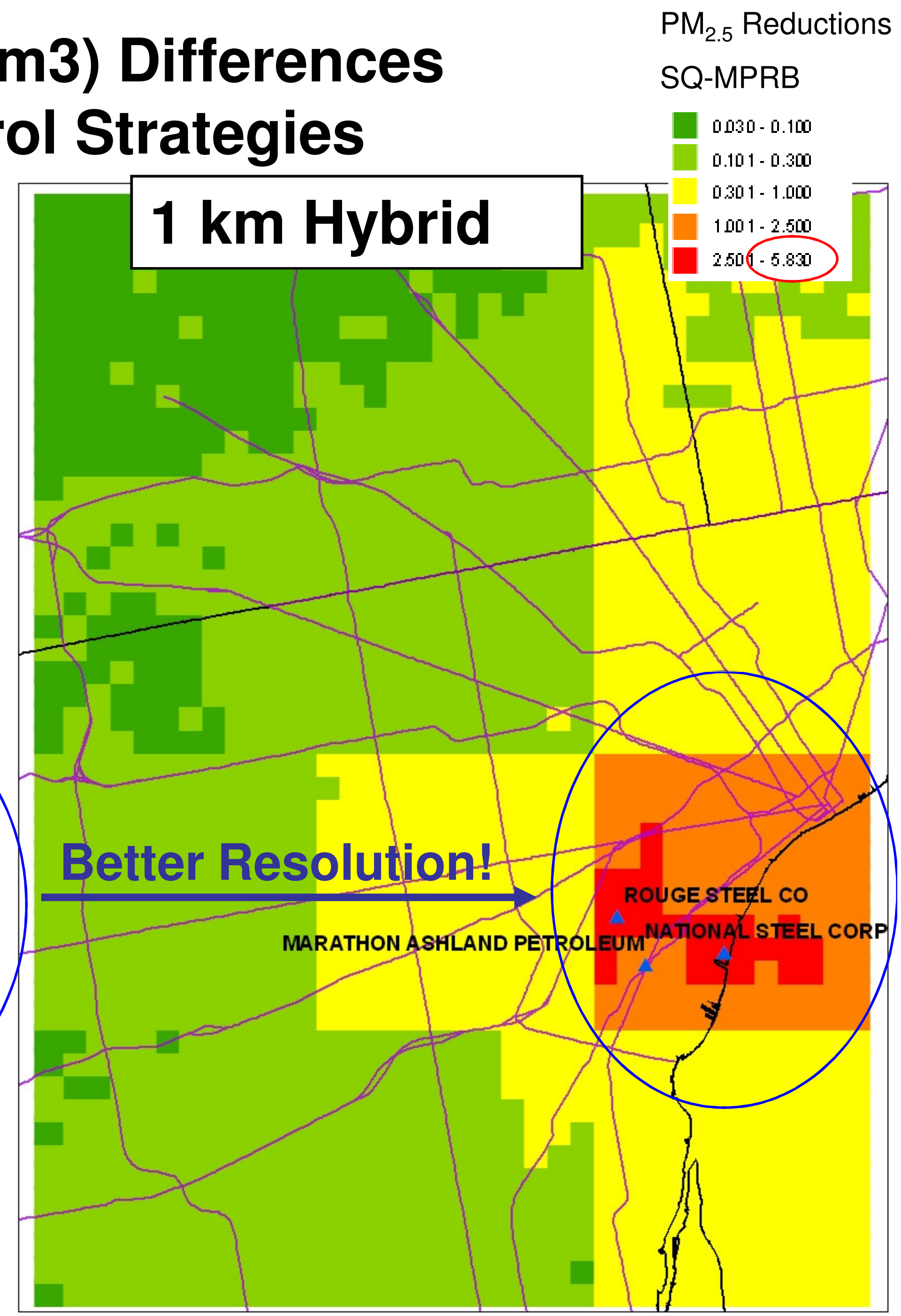
O_3 Design Value Differences (ppb)



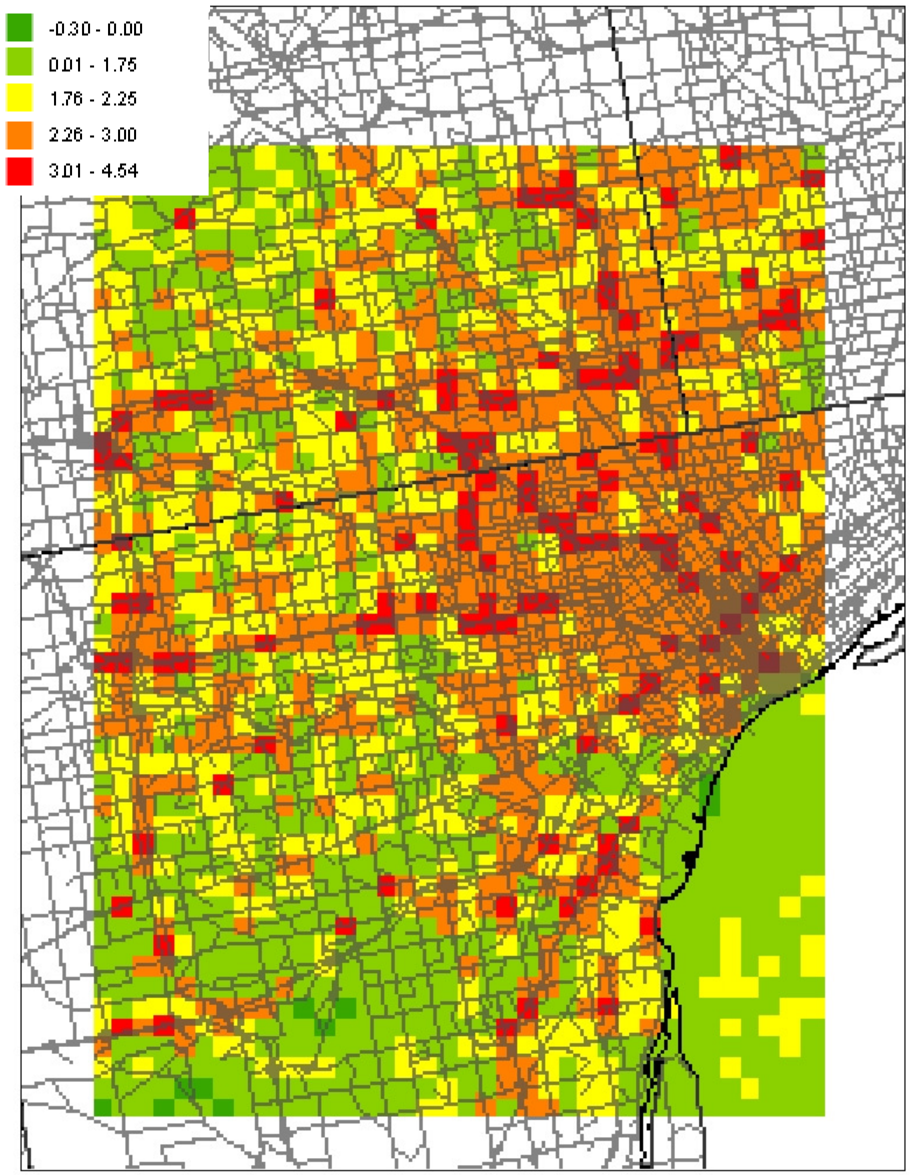
$PM_{2.5}$ Design Value Differences (μg/m3)

Annual $PM_{2.5}$ (µg/m3) Differences Between Control Strategies

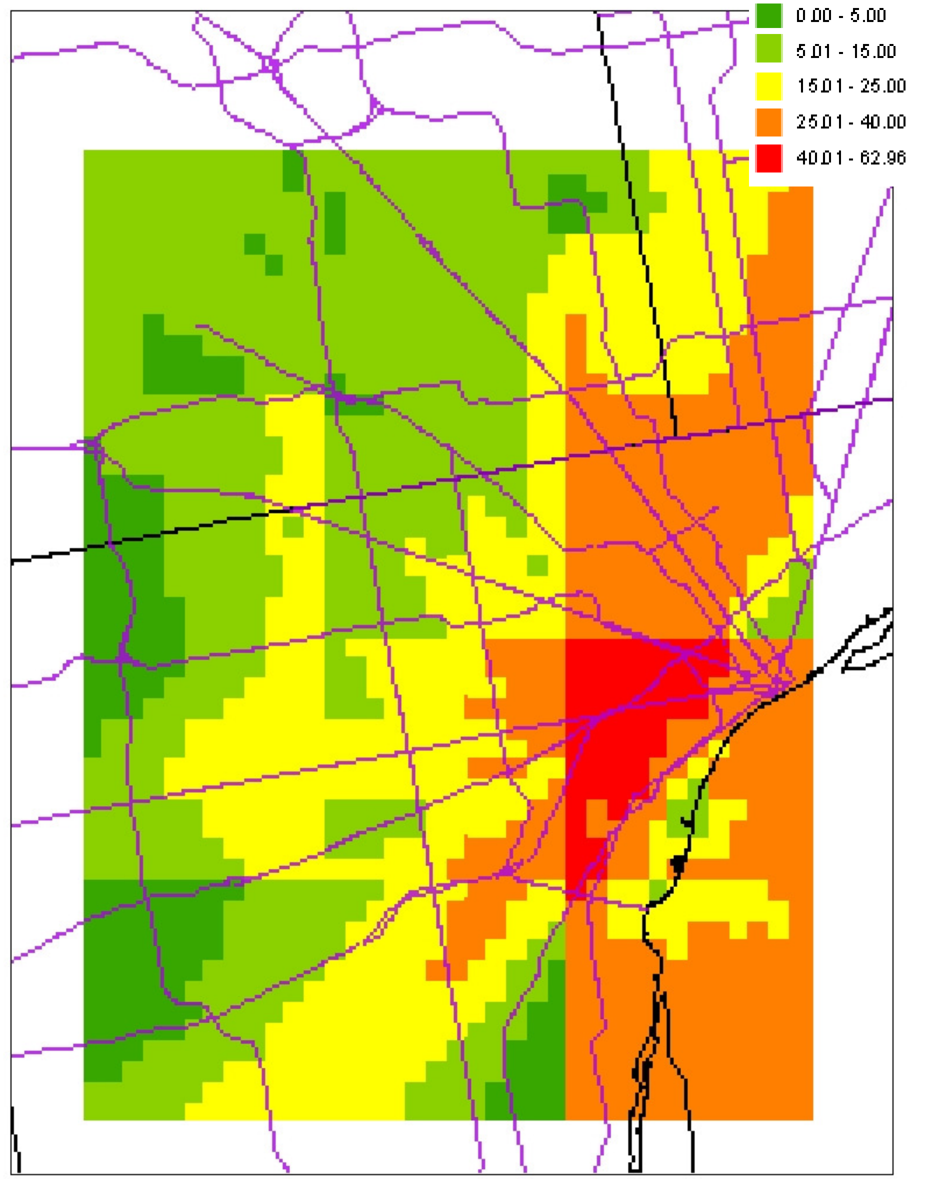




Annual Benzene % Differences

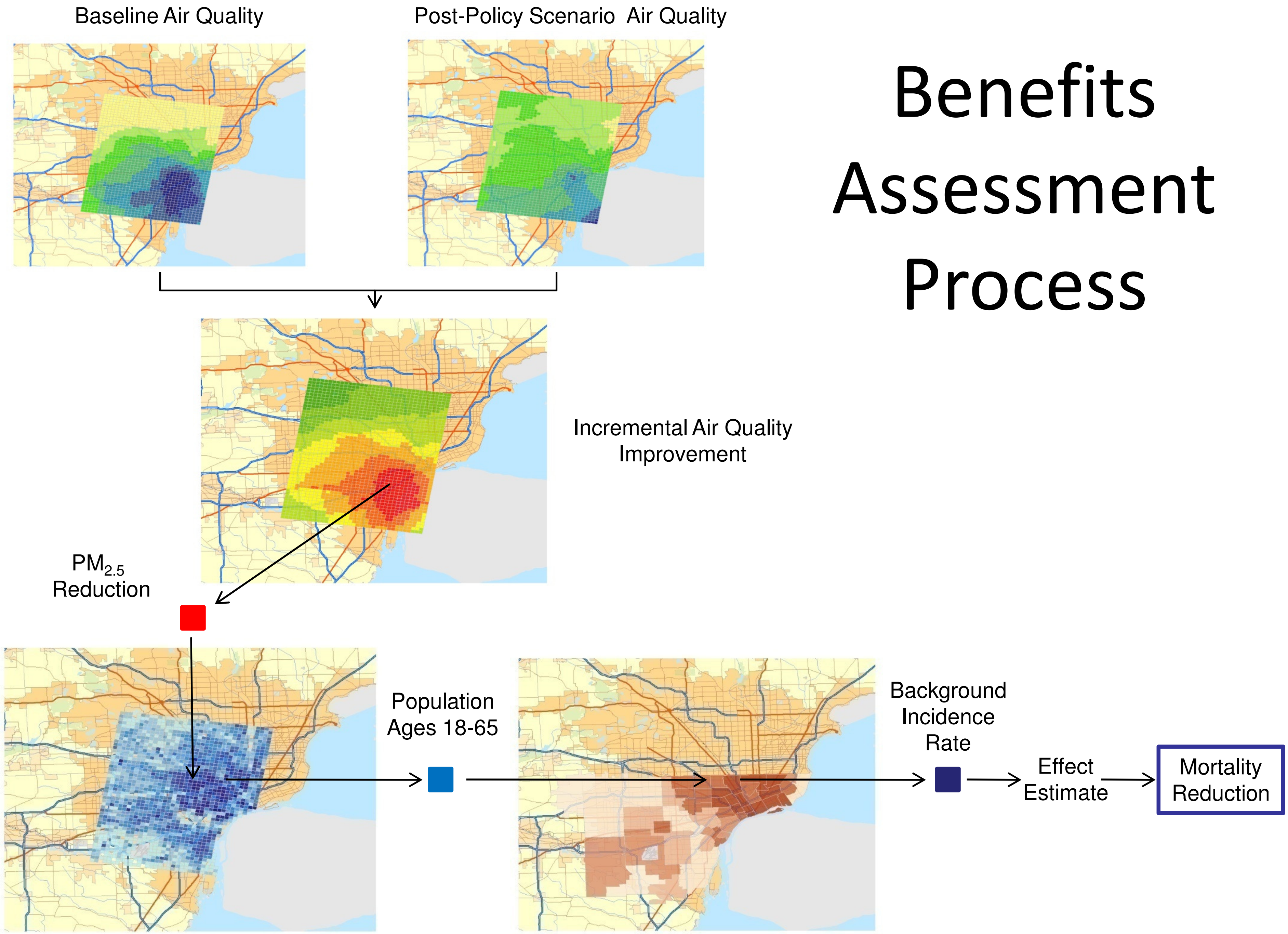


Annual Manganese % Differences



Criteria 3:
$PM_{2.5}$ & O_3
Health Benefits

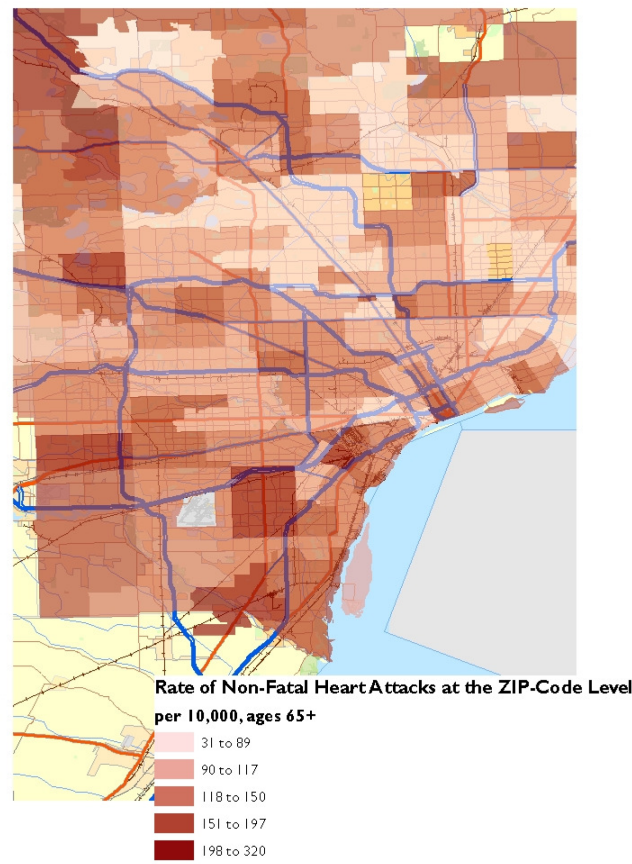
Benefits Assessment Process



Importance of Local Health Data for BenMAP

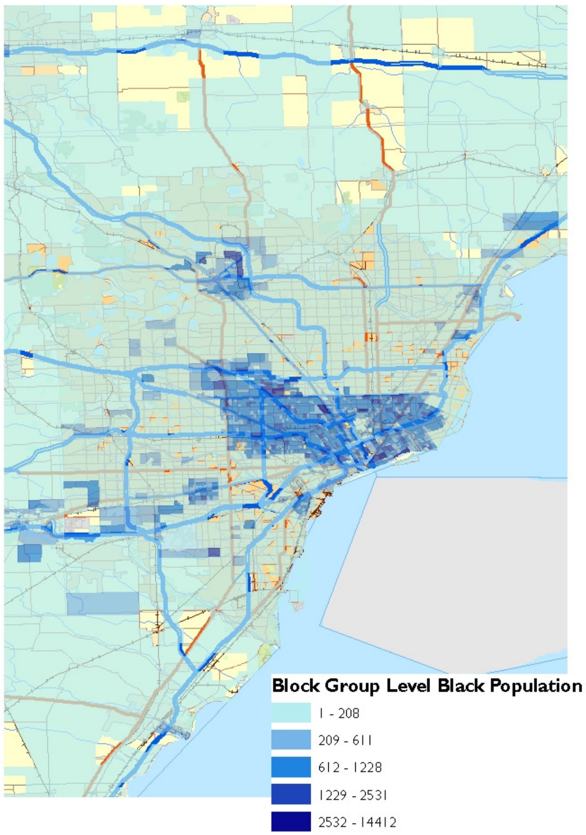
Area	*Age Range*	*Value (per 10,000)*
Nationwide*	0-17	0.03
	18-64	17.8
	65+	149
Detroit*	0-17	No reported cases
	18-64	0 to 36
	65+	31 to 320

*Nationwide rates represent defaults used for national-scale analyses. Detroit estimates provided by Wayne County Dept. of Epidemiology.

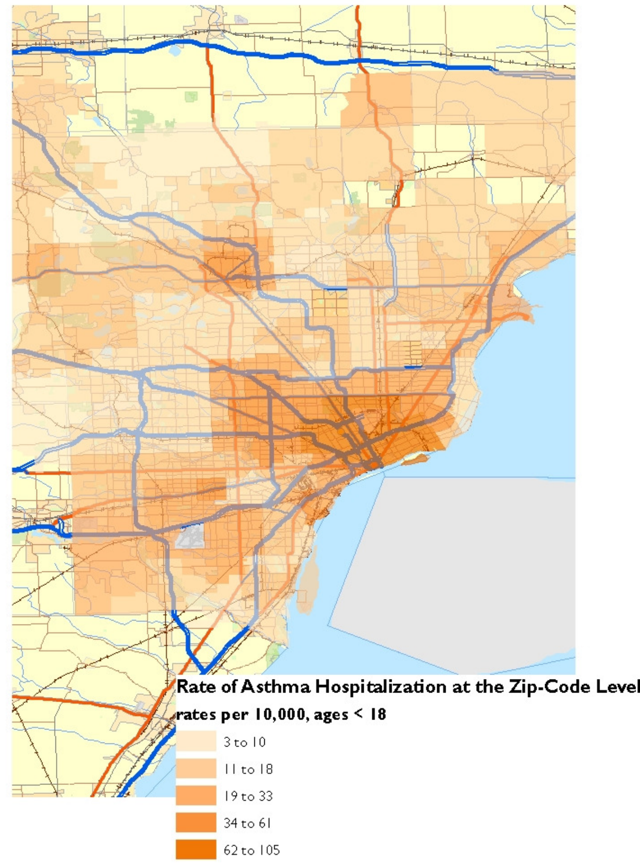


Certain Incidence Rates are Highly Correlated with Subpopulations

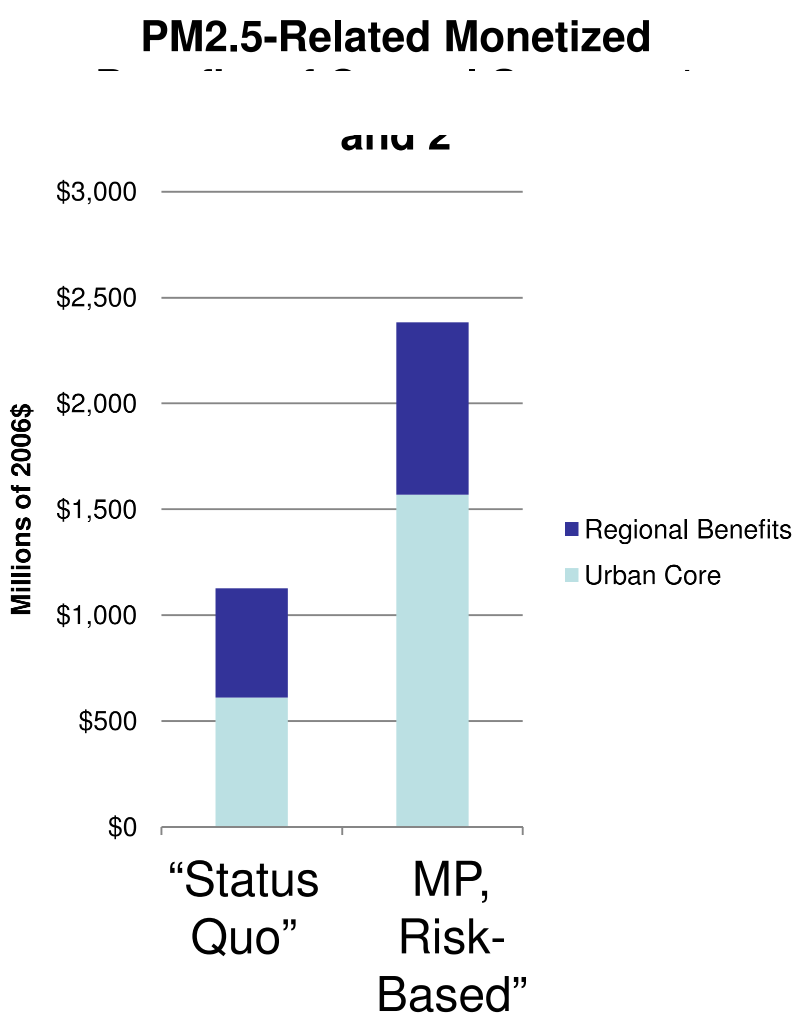
African-American Population

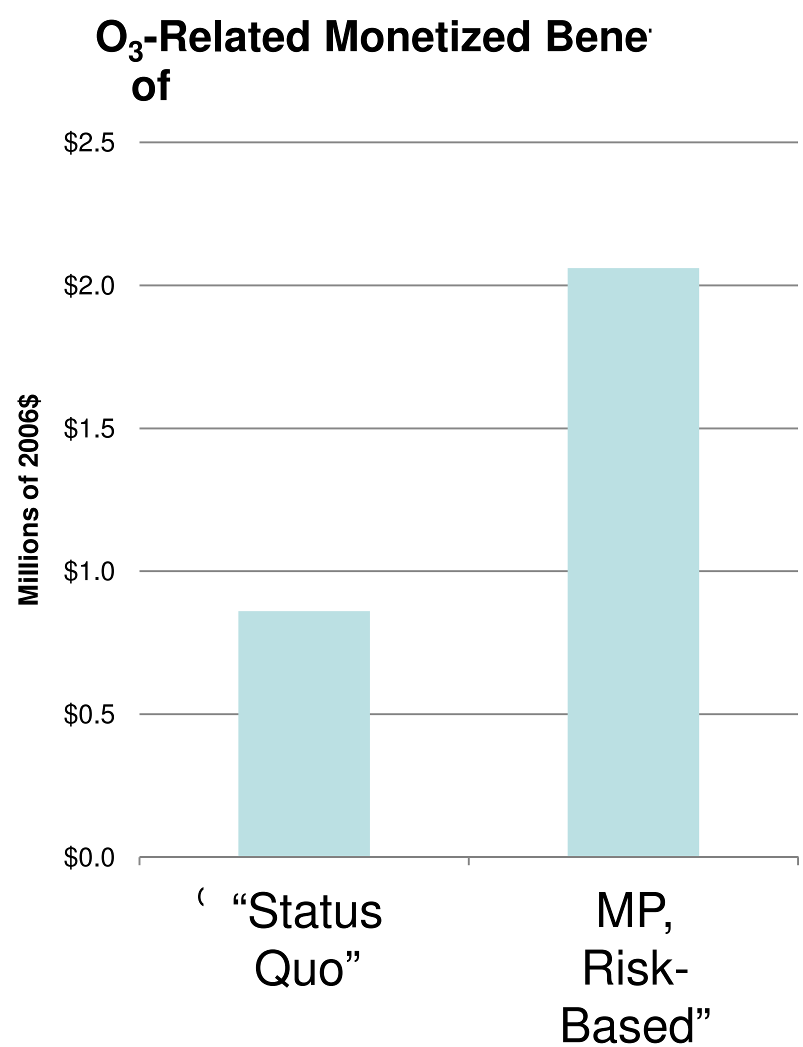


Asthma Hospitalization Rate



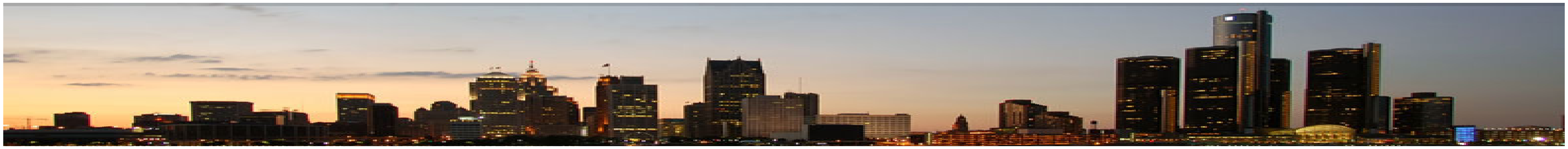
Health Benefits of "Status Quo" vs "MP, Risk-Based" Control Strategy





Benefits-Related Insights

- Fine-scale analyses yield an improved:
  - Estimate of total benefits
  - Characterization of health impacts to specific sub-populations
  - Estimate of distribution of health impacts across locations
- Improved benefits estimates can help us maximize net benefits by applying controls to:
  - Sources nearest population centers
  - Sources nearest susceptible populations



Criteria 4:
Cancer & Non-Cancer Risk

Human Exposure Model (HEM-3)

- Tool for estimating ambient concentrations, human exposures and health risks that may result from air pollution emissions.
  - Used for RTR risk assessments
- Accepts user-supplied gridded modeling results like those from CMAQ or a CMAQ-AERMOD hybrid

"Multi-pollutant, Risk-Based" Control Strategy: Risk Estimates

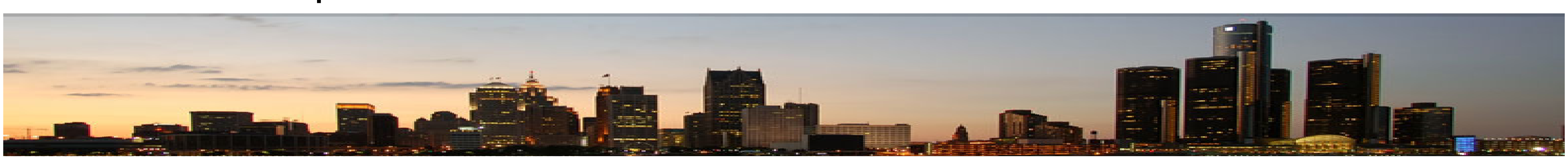
Cancer

- No significant difference in max risk between two strategies
- No significant difference in incidence
- HAP drivers are the same for both strategies
  - Max risk driver: Cadmium
  - Incidence driver: Benzene

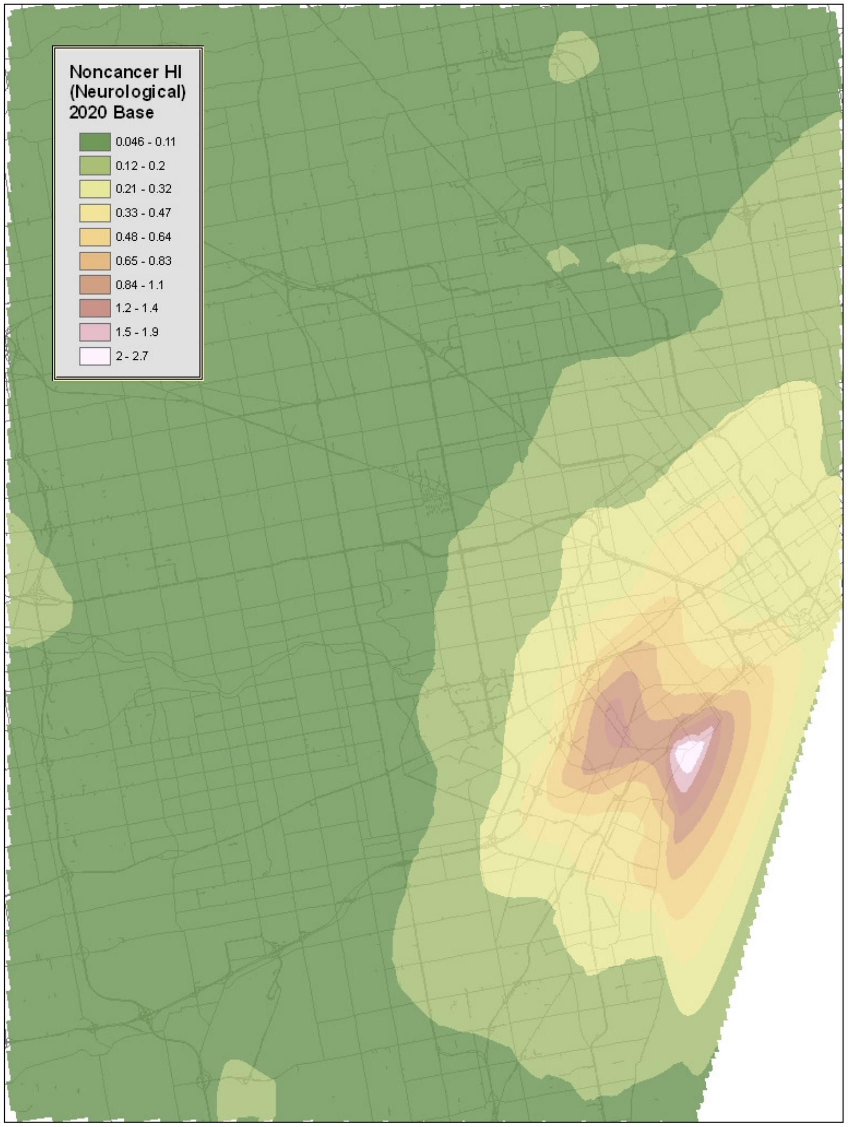
NonCancer

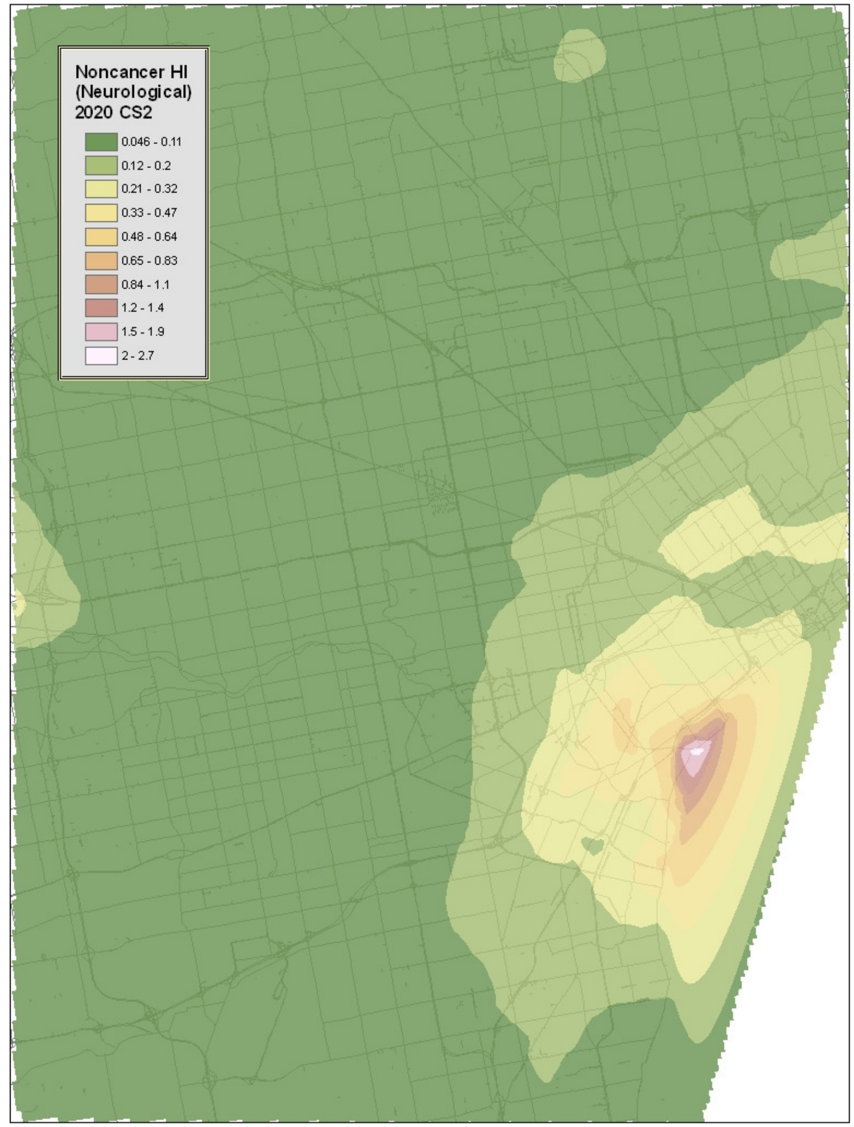
- Max hazard index lower for "MP,Risk-Based" Strategy
  - 2 ("MP, Risk-Based") vs 3 ("Status Quo") vs 3 for 2020 Base
  - About 30% fewer people above HI of 1 due to reductions of Manganese

→Lesson learned: VOC reductions were selected to get O_3 reductions and controls were prioritized based on population-oriented reductions. Perhaps controls for reducing VOC should also be prioritized based on HAP risk?



"Status Quo" vs "MP, Risk-Based" Control Strategy Reductions: Noncancer Risk

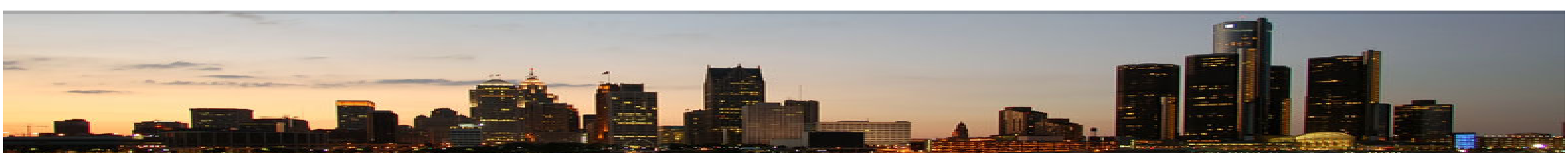




Criteria 5:
Net Benefits
& Cost Effectiveness

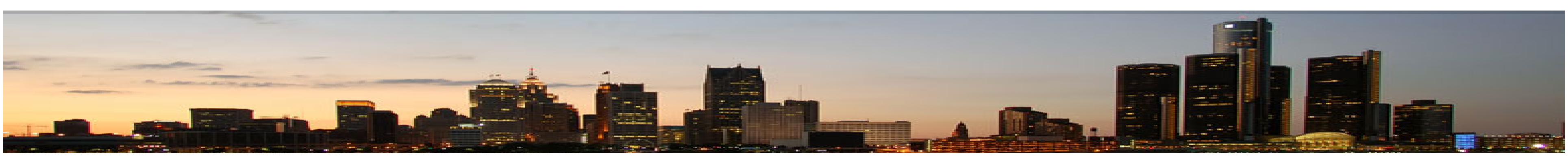
Benefit-Cost Comparison

		"Status Quo"	"MP Risk-Based"
Total Benefits (M 2006$)		**$1,127**	**$2,385**
Change in pop-weighted $PM_{2.5}$ Exposure (ug/m^3)	*Regional*	*0.16*	*0.1666*
	Local	*0.2703*	*0.7211*
Change in pop-weighted O_3 Exposure (ppb)	*Regional*	*0.0005*	*0.0006*
	Local	*0.0318*	*0.0583*
Total Costs (M 2006$)		**$56**	**$66**
Cost per µg/m^3 $PM_{2.5}$ reduced		*$0.50*	*$0.32*
Cost per ppb O_3 reduced		*$2.6*	*$0.58*
Net Benefits (M 2006$)		**$1,071**	**$2,319**
Benefit-Cost Ratio		**20.1**	**36.1**



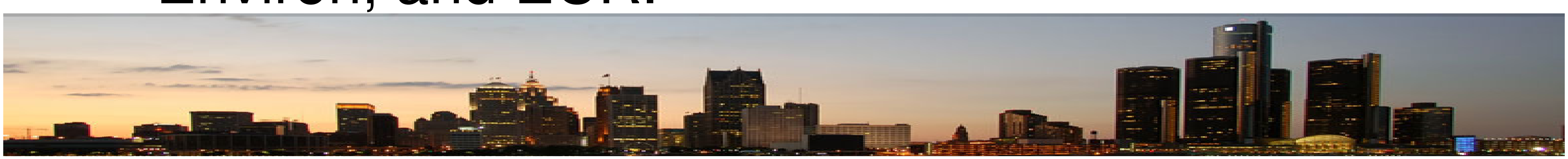
Summary

- First assessment of a Multi-Pollutant, Risk-Based approach to developing control strategies and comparison to a SIP-based approach.
- Found that valuable first steps were:
  - Develop & evaluate a “platform” for the Detroit MP analyses; and
  - Fully understand the AQ issues for the area through development of a Conceptual Model
  - Collect local-scale information including emissions, AQ modeling, control and health data
- “MP, Risk-Based” approach met all “Criteria for Success”
  - Same or greater reductions at all monitors for $PM_{2.5}$ & O_3, including greatest reductions at Michigan projected nonattainment monitors
  - Improved air quality regionally and in urban core for O_3, $PM_{2.5}$, and selected air toxics
  - Greater benefits (~2x) for $PM_{2.5}$ & O_3 with “MP, Risk-Based” Control Strategy
  - Reduction in non-cancer risk, though no significant change in cancer risk
    - Lesson learned: VOC controls could also be prioritized based on HAPS risk.
  - More cost effective and beneficial

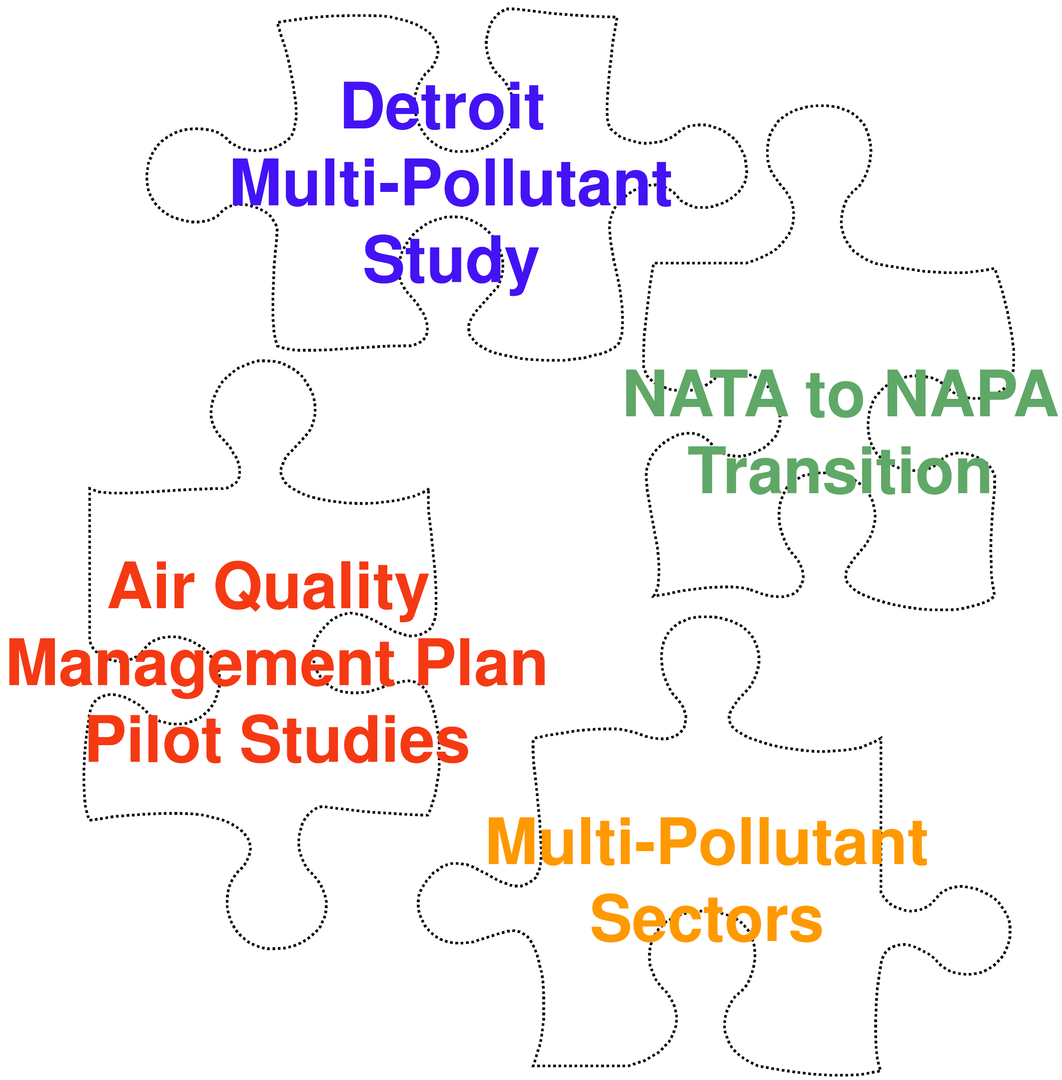


Additional Acknowledgements

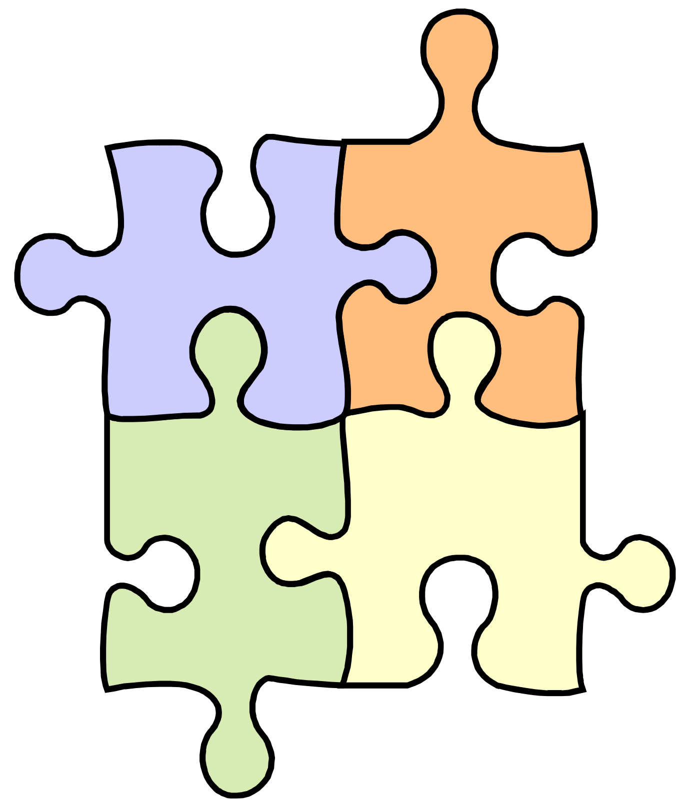
- Assistance from outside OAQPS includes OTAQ, CAMD, ORD, MDEQ, SEMCOG, LADCO.
- Others within OAQPS who have been invaluable in their assistance to the project include Roger Brode, Kirk Baker, Bryan Hubbell, David Misenheimer, Josh Drunkenbrod, Brian Timin, Kim Teal, Brenda Shine, Keith Barnett, Pat Dolwick, and Norm Possiel.
- Contractor support was provided by CSC, Environ, and ECR.



Multi-pollutant Future



Bringing it together . . .



Air Quality Mgmt Planning

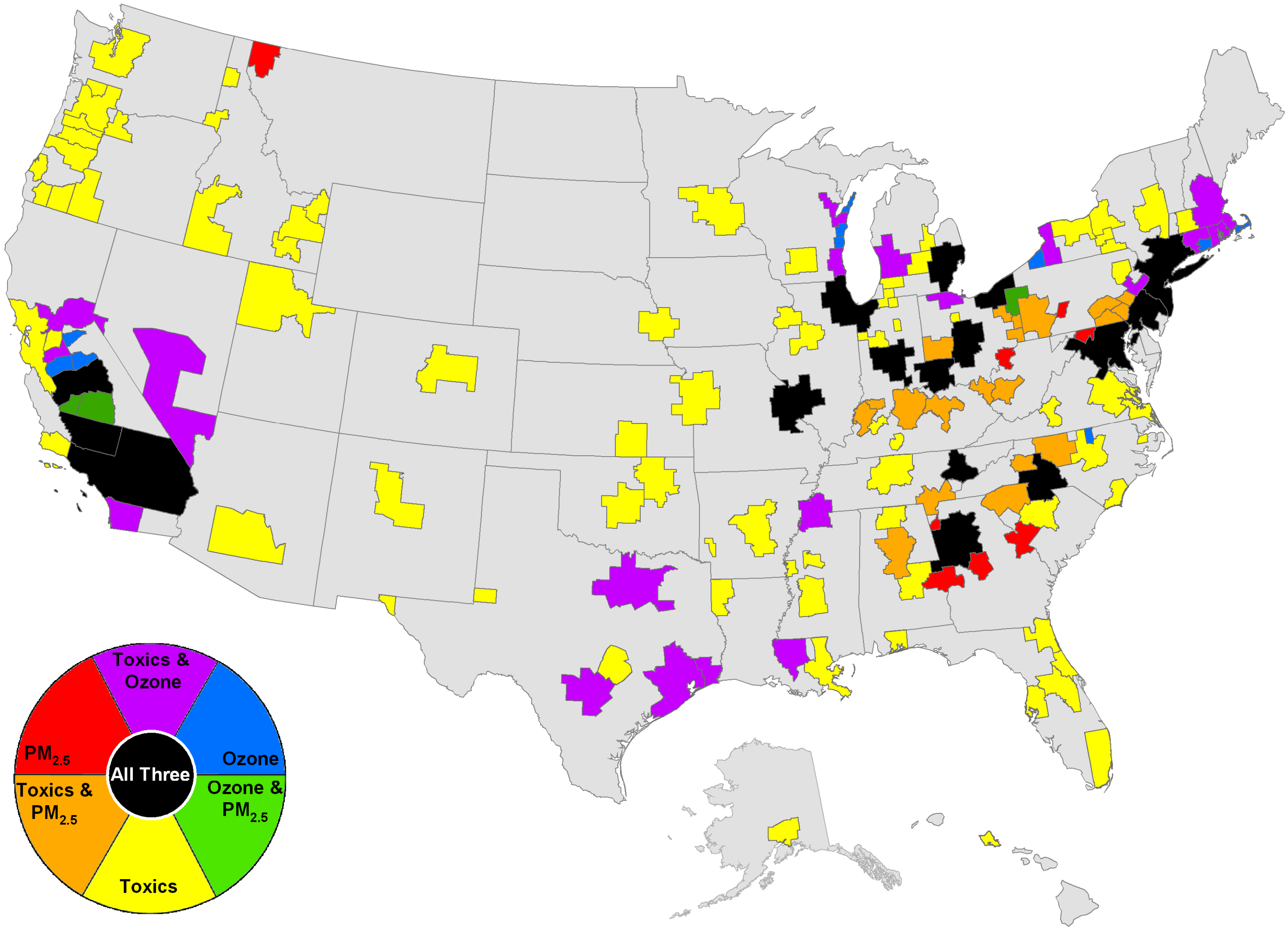
- Air Quality Management Plan (AQMP) Pilot Studies
  - EPA/OAQPS partnering with three areas to integrate non-traditional planning into air quality management
    - St. Louis (Illinois and Missouri)
    - New York
    - North Carolina
  - Encourage areas to create plans that comprehensively address air quality concerns such as attainment and maintenance of criteria pollutant standards, sector-based emission reductions, improvements in regional haze and visibility, and HAP risk reductions
- Detroit MP Study <u>informs</u> AQMP pilot areas & others
  - Extended SIP tools towards a multi-pollutant analytic capability
  - Demonstrated ability to address air quality issues in comprehensive manner consistent with 2004 NAS report
- Multi-pollutant Sector-based Approaches
  - Led by OAQPS Sectors Policies & Programs Division (Peter Tsirigotis)
  - Streamline and optimize control requirements and maximize control efficiencies for sectors across pollutants & CAA-mandated programs

Multi-Pollutant Characterization

- The Multi-Pollutant Report: Technical Concepts and Examples (revised July 2008)*
  – Promote common understanding of multi-pollutant concepts to foster collaboration within and across the technical and policy disciplines of air quality management
  – Explore multi-pollutant analytic issues
  – Illustrate the initial development and implementation of a technical infrastructure to support a multi-pollutant approach to air quality management.
    - Integrated emissions inventory: NEI
    - Integrated monitoring network: NCore
    - “One atmosphere” air quality modeling: CMAQ model
    - Multi-pollutant modeling platform: 2002/05 & projected future years

* Available at: http://www.epa.gov/air/airtrends/specialstudies/20080702_multipoll.pdf

Nexus of PM2.5, ozone, and air toxics



Ozone and/or PM2.5 concentrations above the NAAQS for 2003-2005 and toxics in the top 10% of modeled risk estimates from NATA 1999 data based on the max county data aggregated to combined statistical areas (CSA) or core based statistical areas (CBSA) when possible. County level data is shown where no aggregation occured.

Evolving Beyond NATA: National Air Pollutant Assessment (NAPA)

- OAQPS currently planning for NAPA product which would be the successor to NATA
  - Plan for interim 2005 NATA product that will include national characterization of ozone and PM2.5
  - Initial NAPA effort to be based on 2008 NEI
- 2008 NAPA—provide national characterization of air quality across multiple pollutants using both modeled and monitored data and provide these data and exposure/risk metrics (yet to be defined)
- Improves our understanding of multi-pollutant nature of AQ issues as part of outreach to stakeholders/public and in designing programs and policies to achieve effective environmental solutions