Detroit Multi-pollutant Pilot Project: Summary Results

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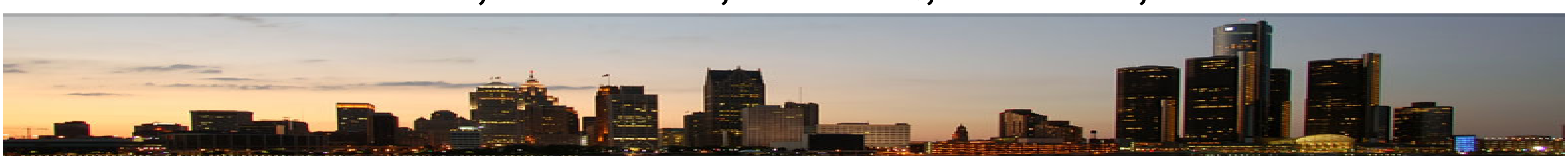
Assistance from outside OAQPS includes MDEQ, SEMCOG, LADCO, OTAQ, CAMD, & ORD.



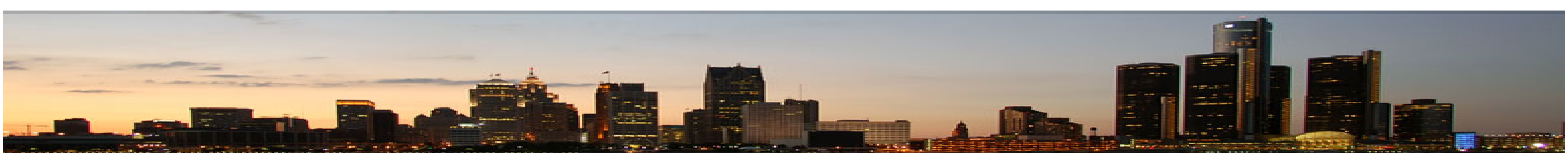
Detroit Multi-pollutant Pilot Project: Overview

- 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.*

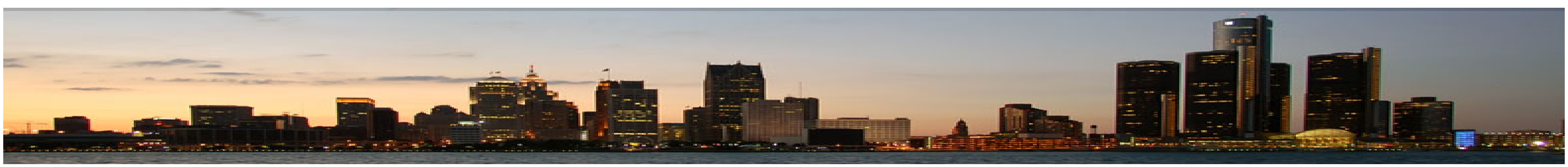


Detroit Multi-pollutant Pilot Project: Highlights

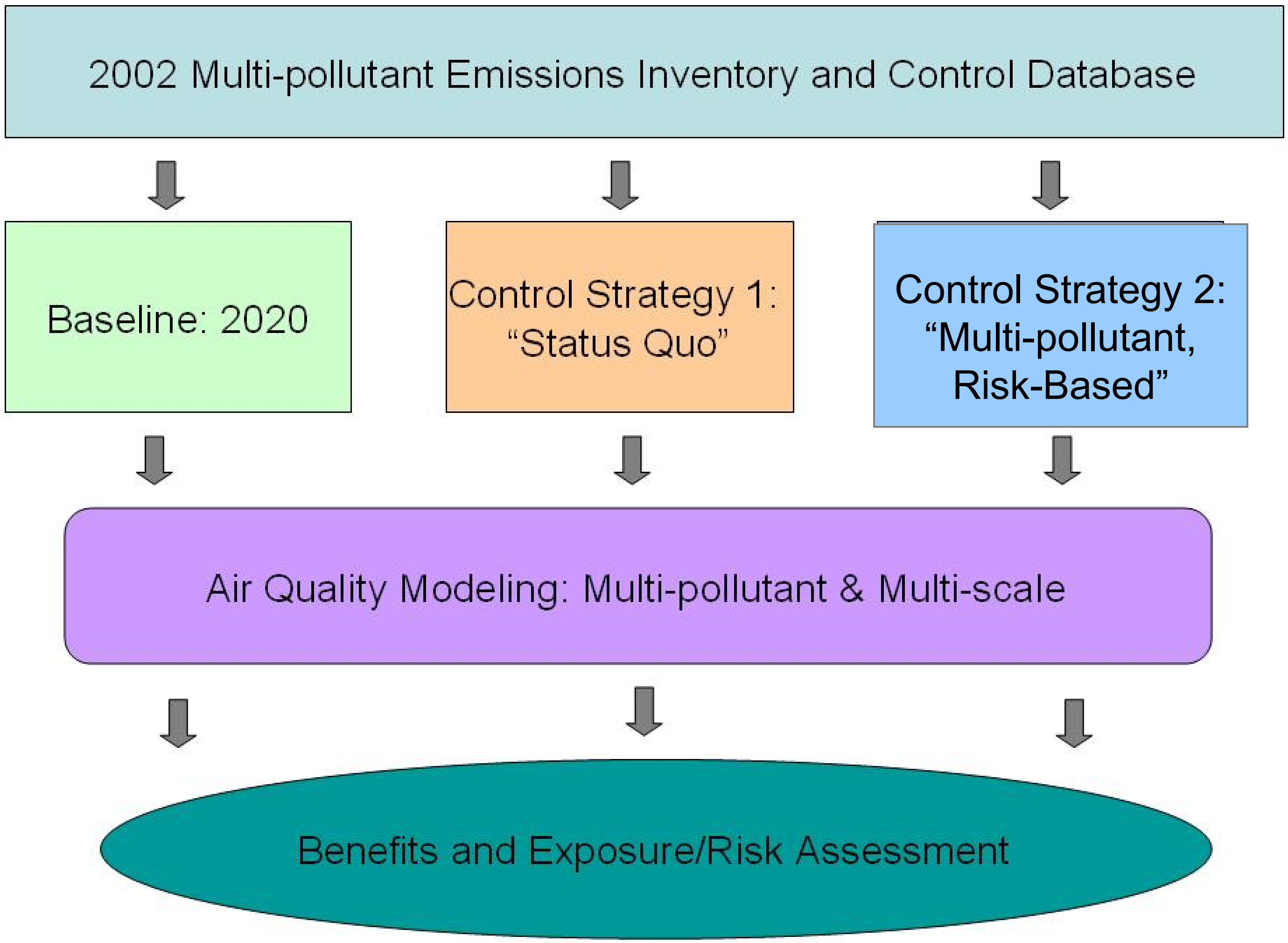
- This project is our 1st assessment of a Multi-Pollutant, Risk-Based approach to developing control strategies and comparison to a SIP-based approach.

- 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

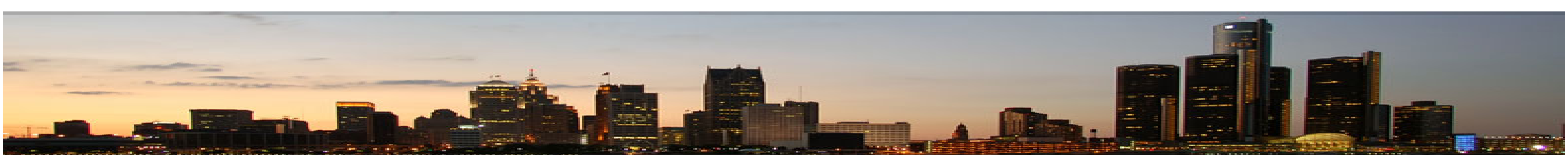


Control Strategy Development & Assessment Overview



Control Strategy 1: "Status Quo"

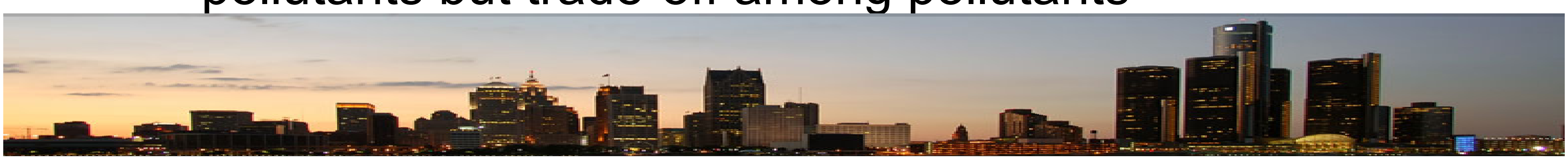
- "Status Quo" because controls were selected to achieve separate O_3 and $PM_{2.5}$ attainment goals based on least-cost criteria
  - $PM_{2.5}$ Controls from EPA $PM_{2.5}$ NAAQS RIA 15/35
  - O_3 Controls from MDEQ Draft O_3 SIP Strategy Plan for 85 ppb NAAQS
- However, controls were "multi-pollutanized" 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

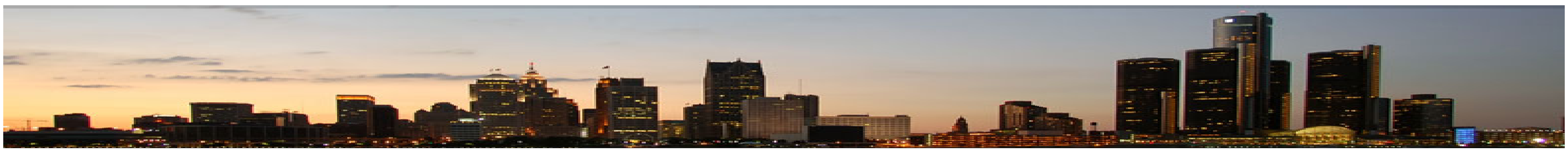


Process to develop “Multi-pollutant, Risk-Based” control strategy

- 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

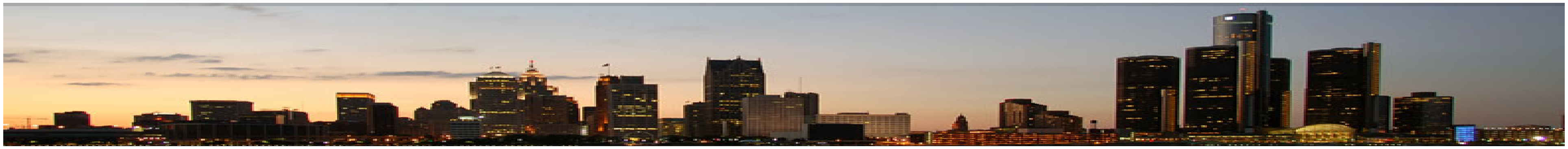
Inorganic HAPS	Organic HAPS/VOC	PM_{10} & $PM_{2.5}$
92.0%	18.6%	92.0%

- 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

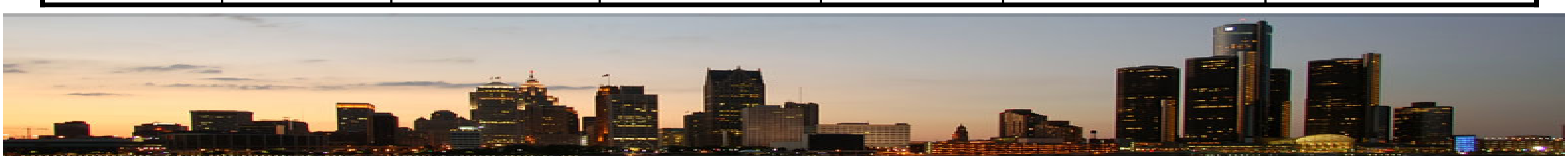
$PM_{2.5}$	SO_2	VOC	NO_x	CO
50%	50%	50%	50%	50%



"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

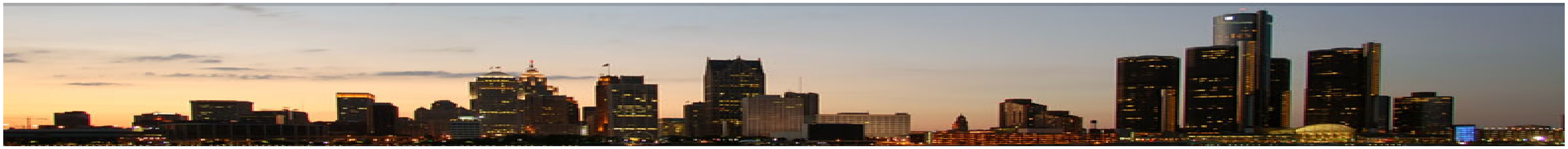


"Status Quo" vs. "Multi-pollutant, Risk-Based": Toxic Pollutant Emissions Changes

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

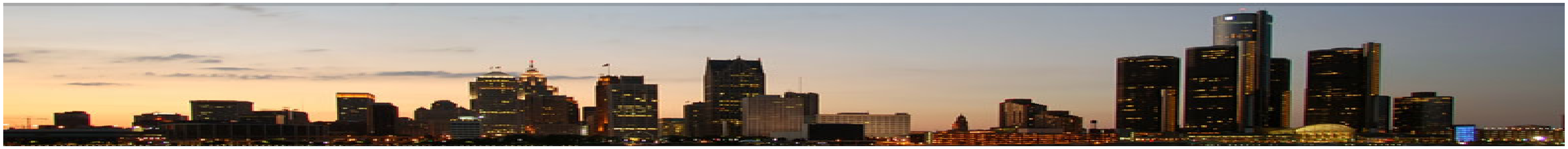
MPRB > Reductions

SQ > Reductions

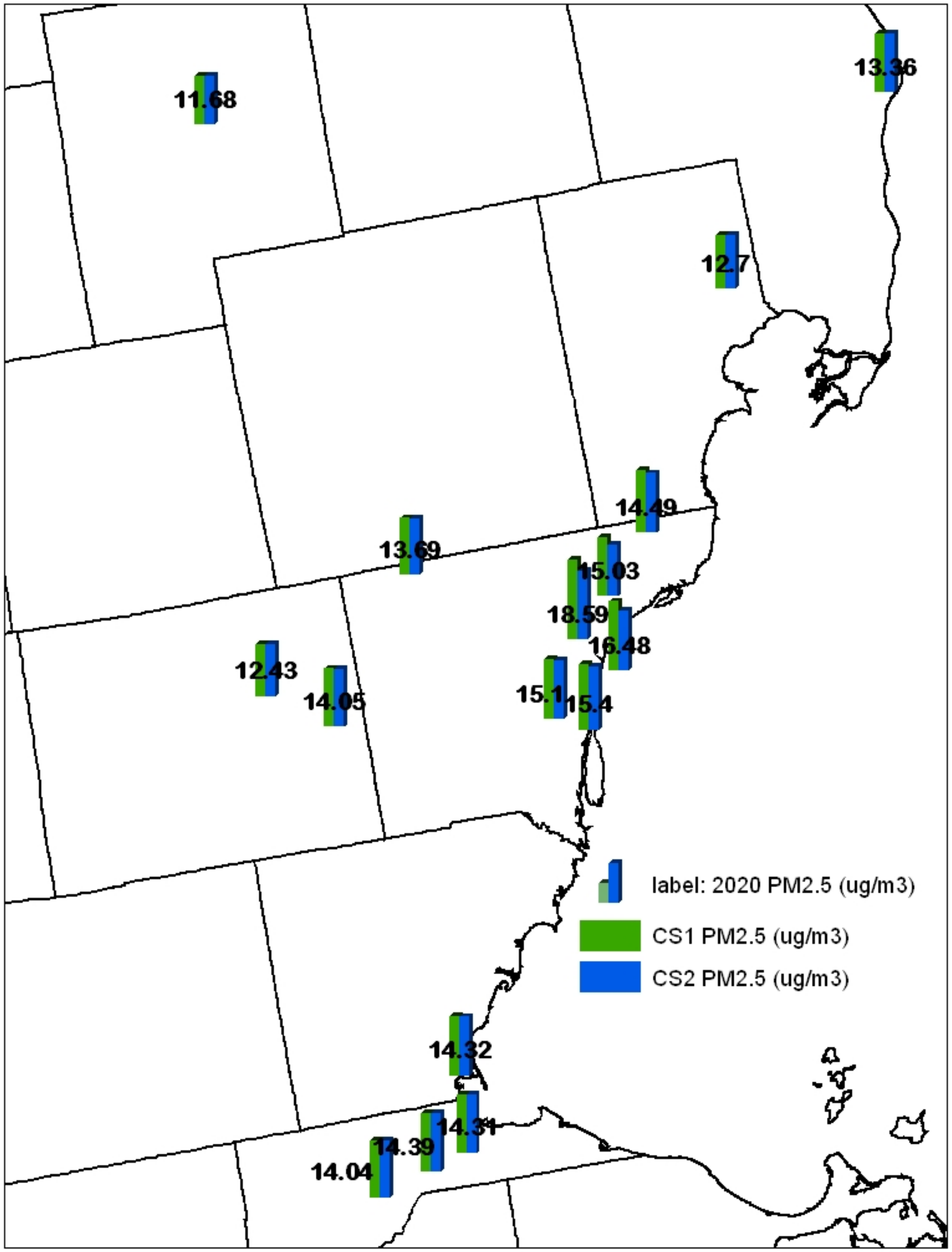


Criteria for "Success"

- 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



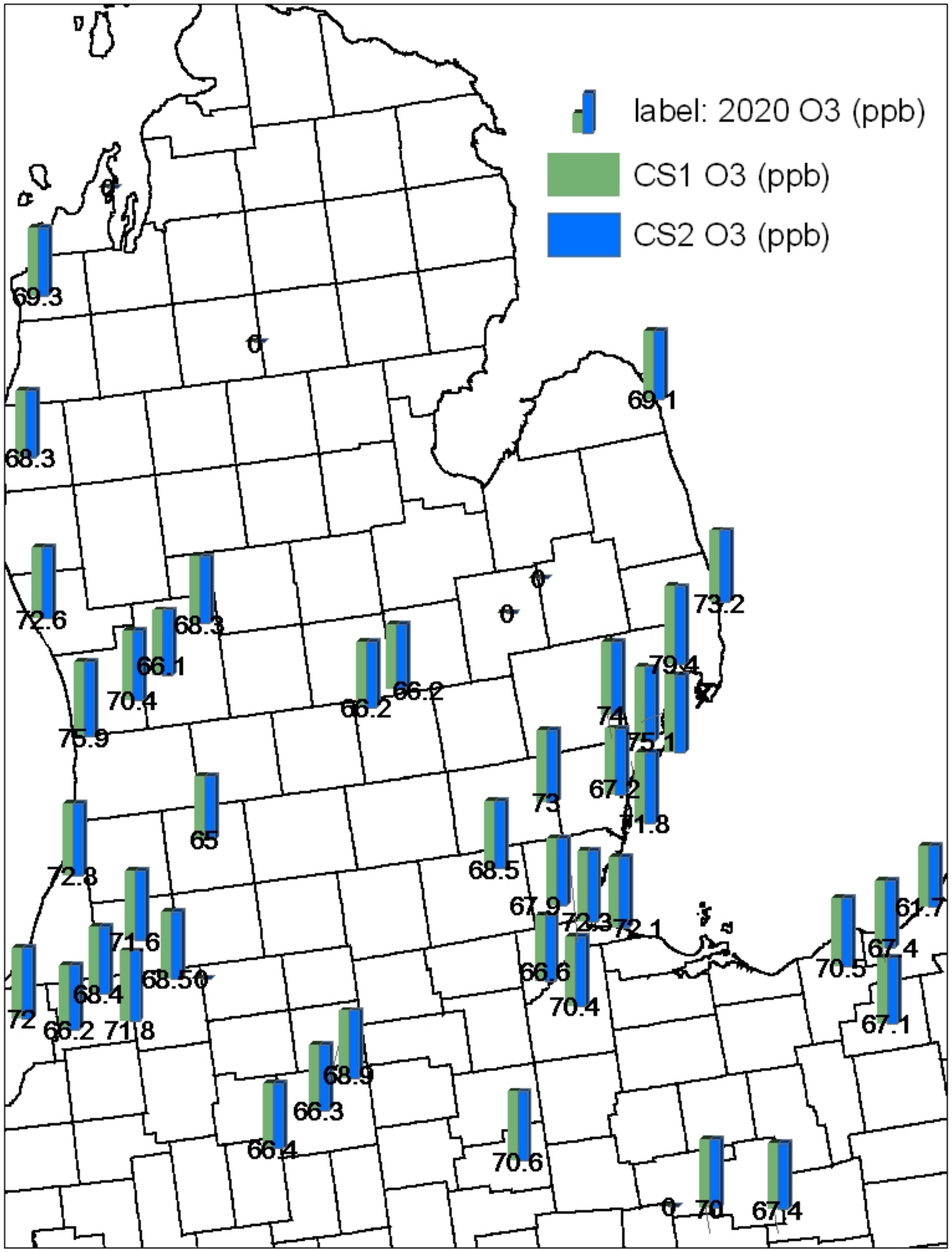
$PM_{2.5}$ Design Values for the Annual Standard for 2020 & 2 Control Strategies

- 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



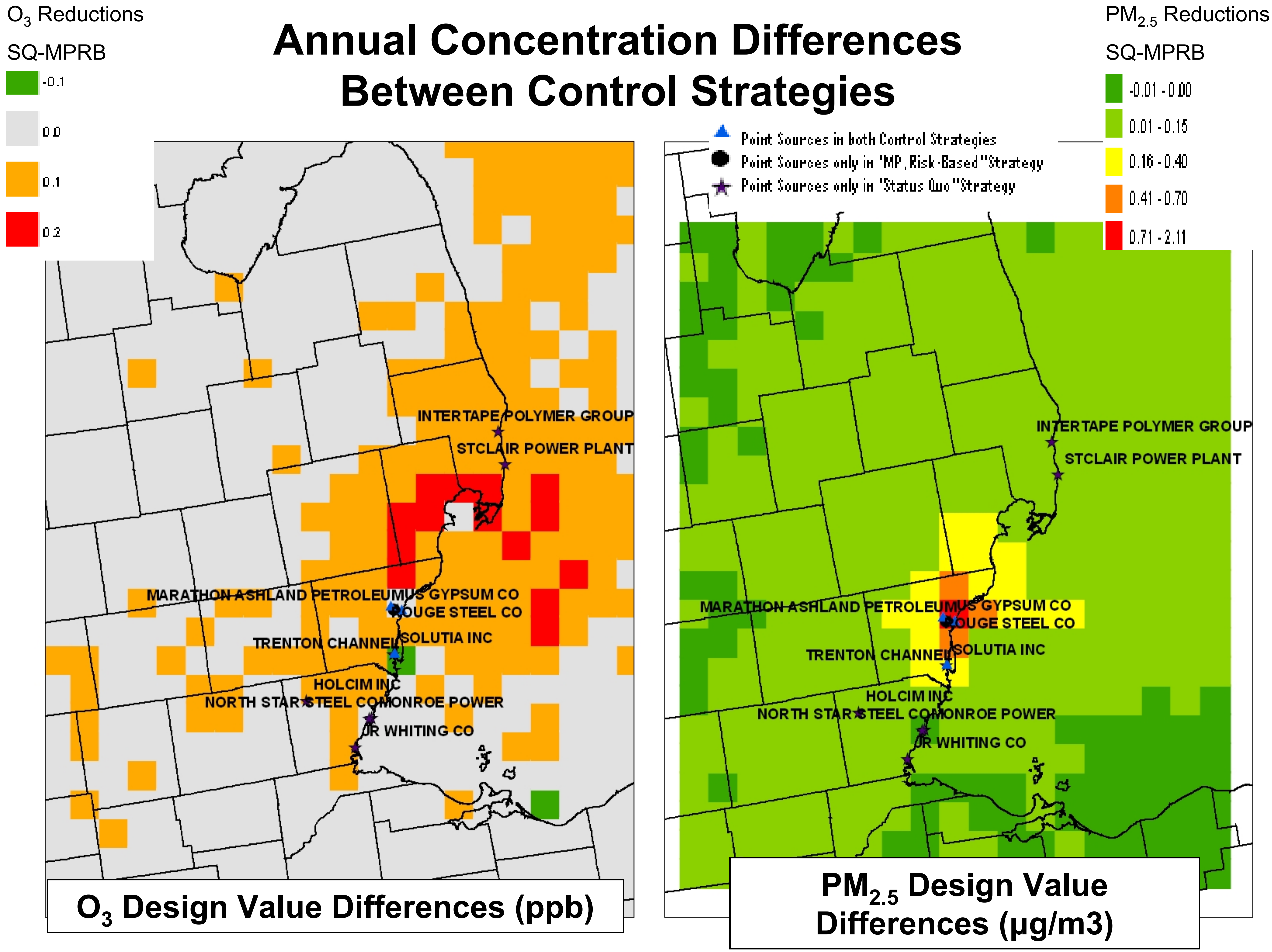
- Small reductions at monitors for either control strategy. All monitors under 85 ppb in 2020.
- "MP, Risk-Based" reductions are always equal or greater than "Status Quo"

O_3 Monitors in Detroit Area

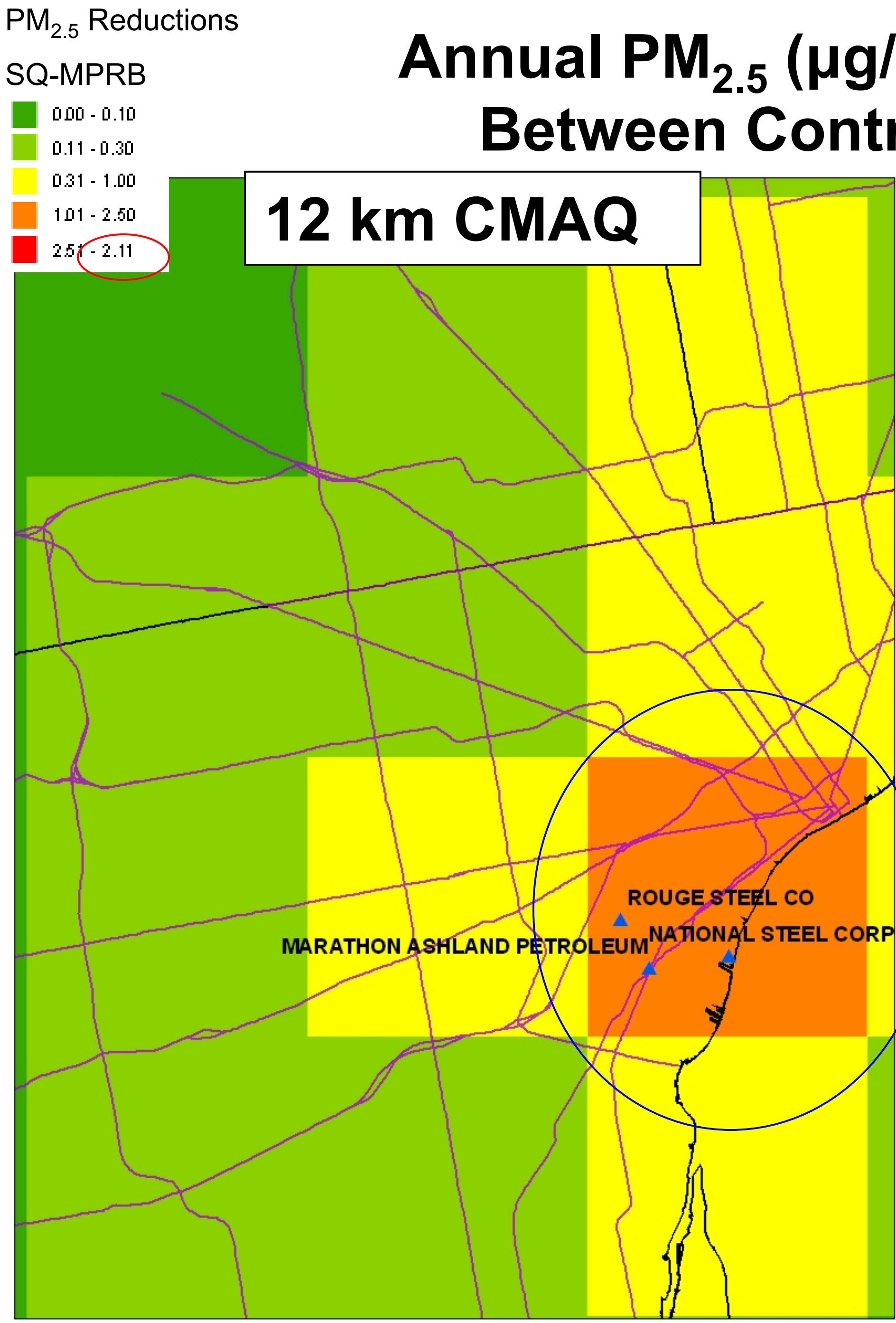
Max 8-hr O_3 Design Values (ppb)	***2020***	***SQ***	***MP, RB***
260991003 Macomb	78.7	78.6	78.4
261610008 Washtenaw	73.0	72.9	72.8
261630016 Wayne	71.8	71.7	71.6

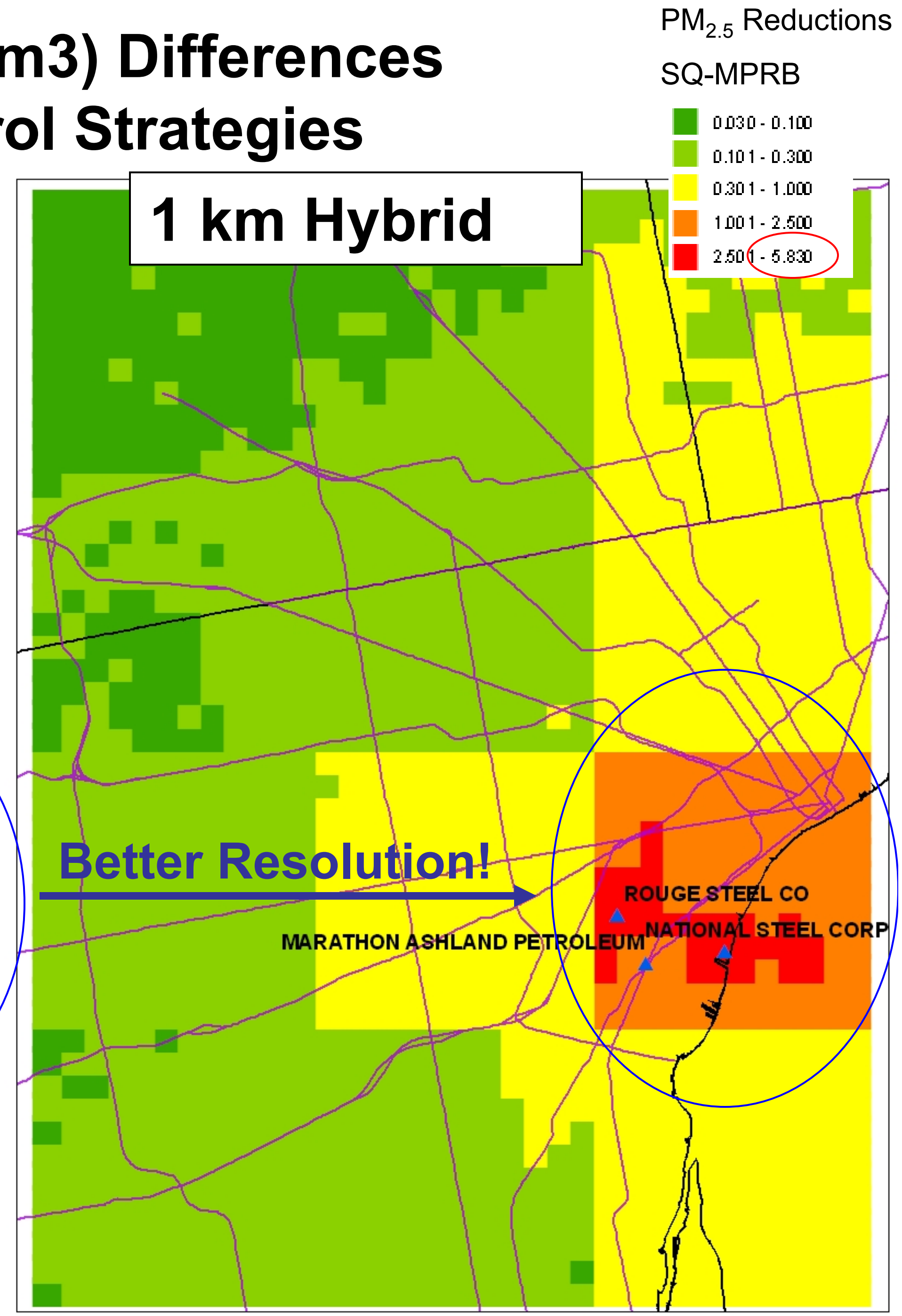
Criteria 2:
Air Quality Improvements
Across Region
& in Urban Core

Annual Concentration Differences Between Control Strategies

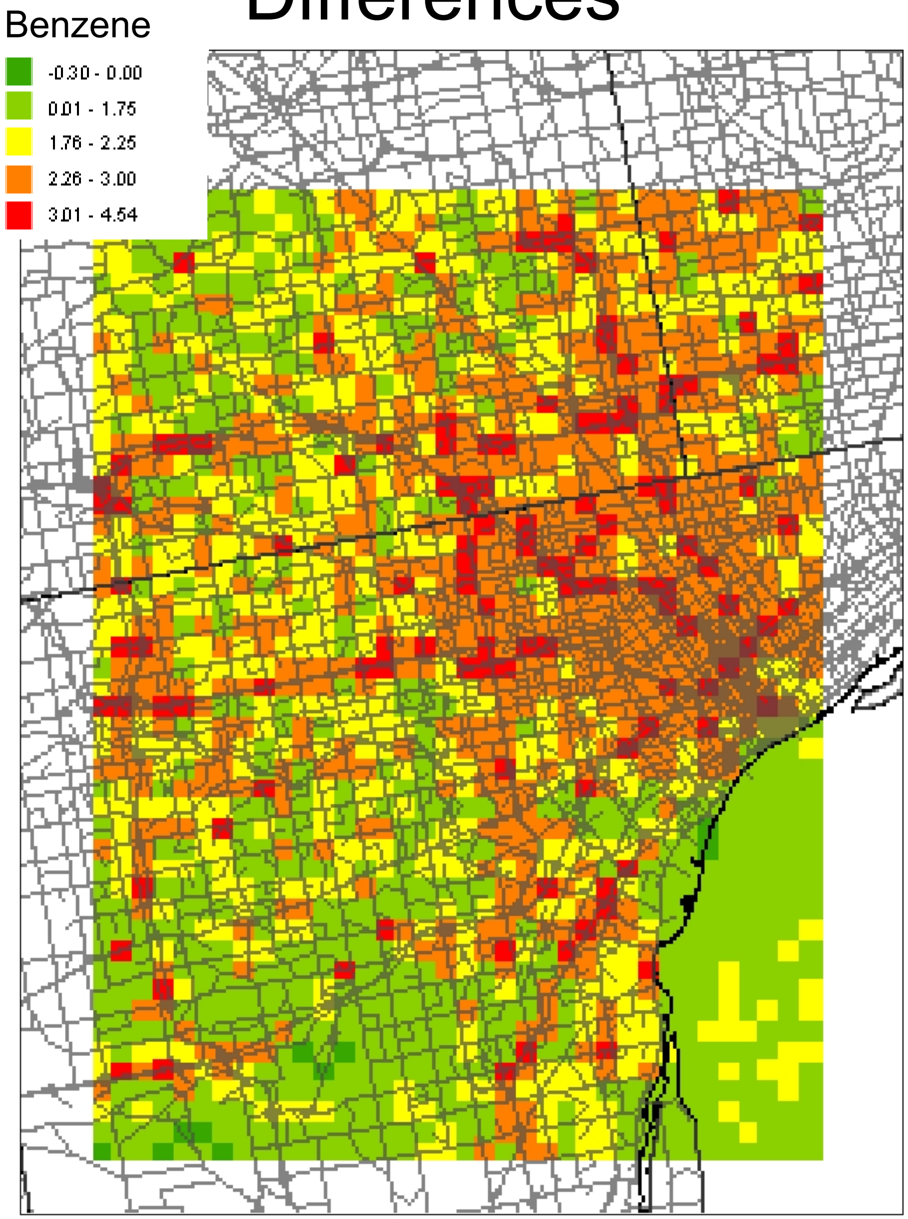


Annual $PM_{2.5}$ (µg/m3) Differences Between Control Strategies

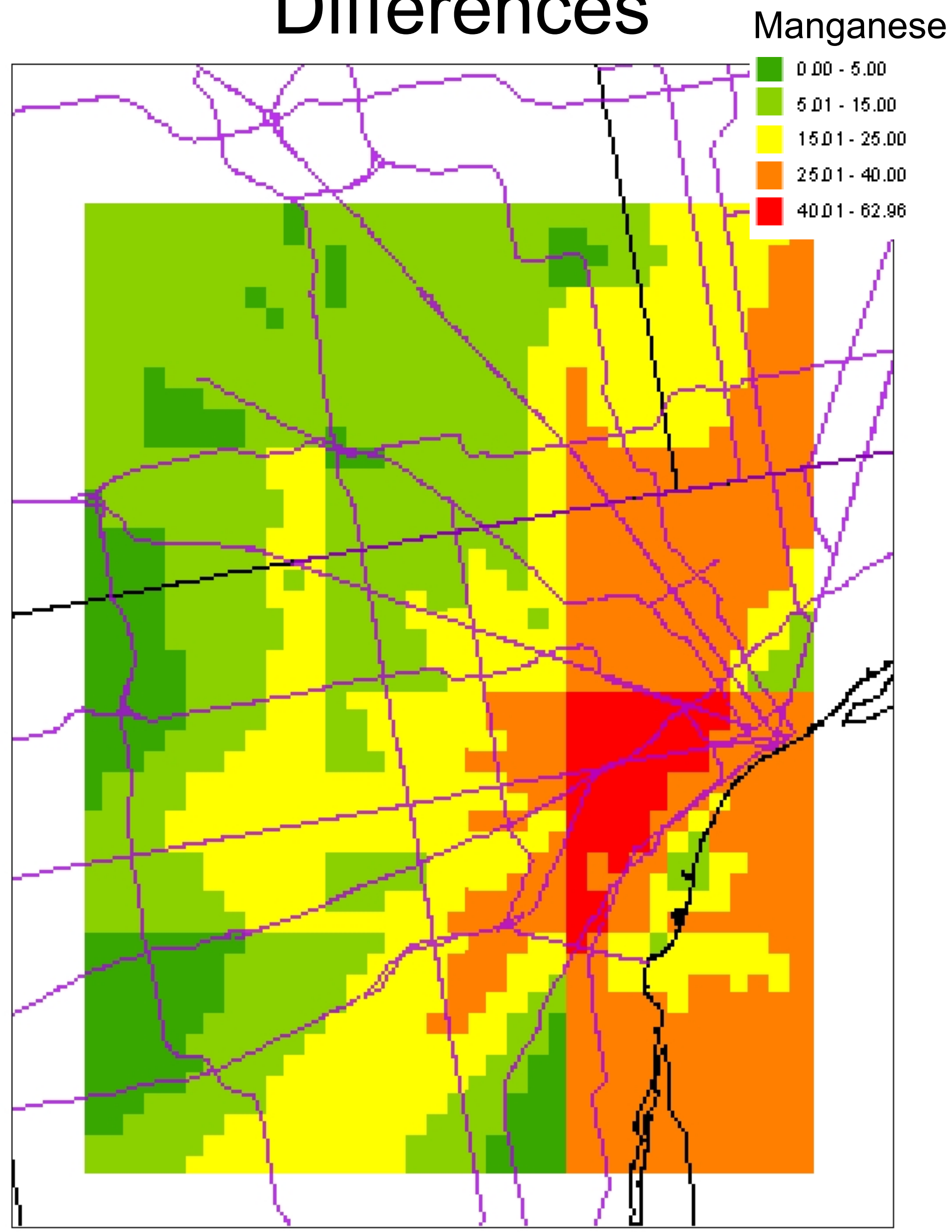




Annual Benzene % Differences

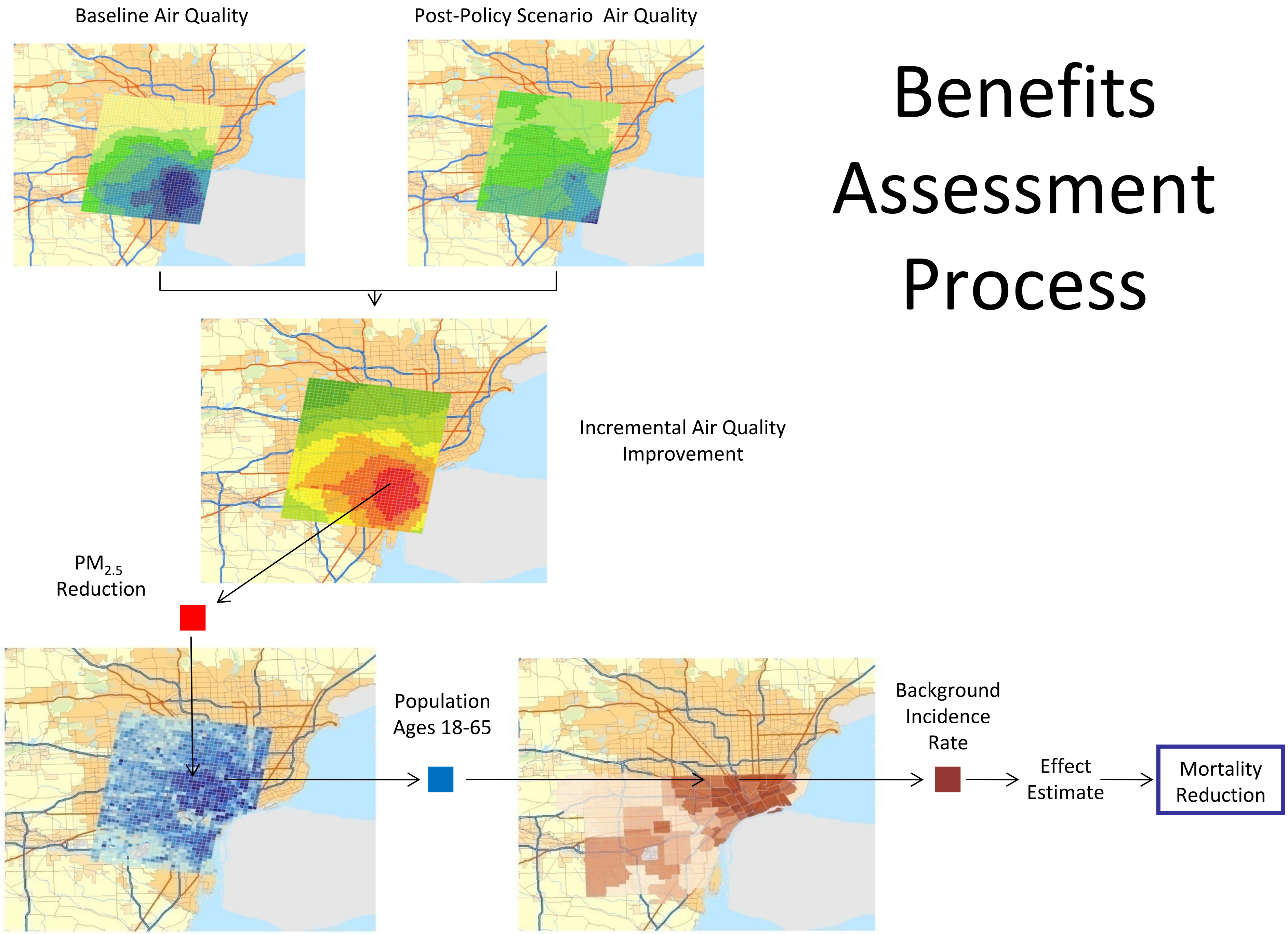


Annual Manganese % Differences



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

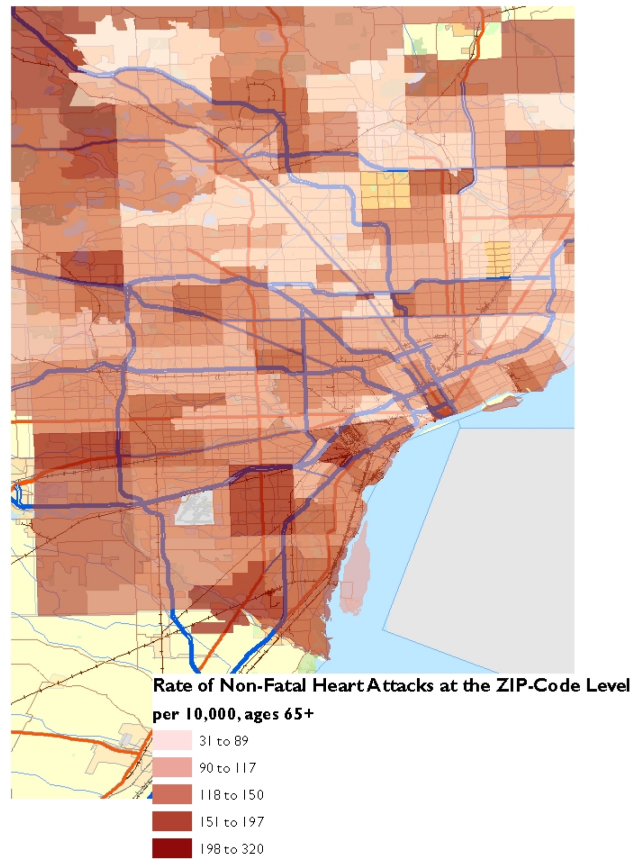
Benefits Assessment Process



Importance of Local Health Data for BenMAP

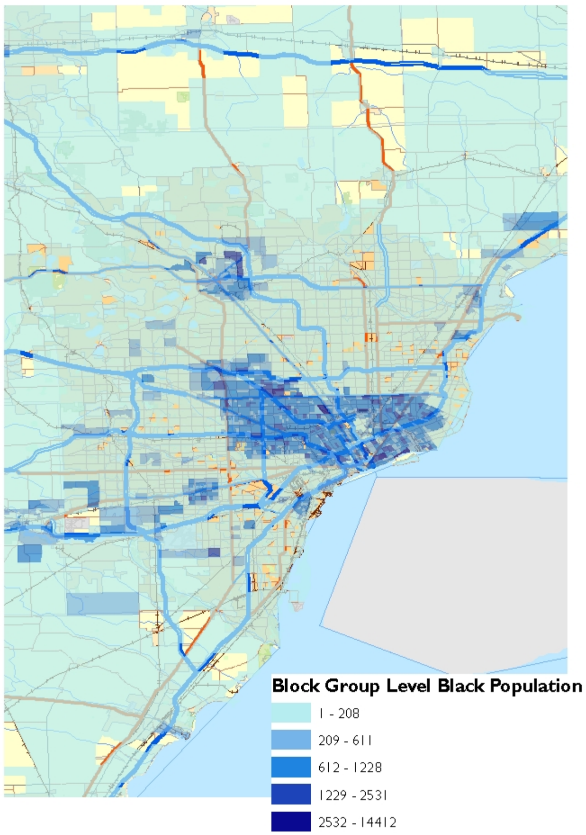
Area	*Age Range*	*Value (per 10,000)*
Nationwide*	0-17	0.03
	18-64	17.8
	65+	149
Detroit*	0-17	No reported cases
	18-64	0 to 36
	65+	31 to 320

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

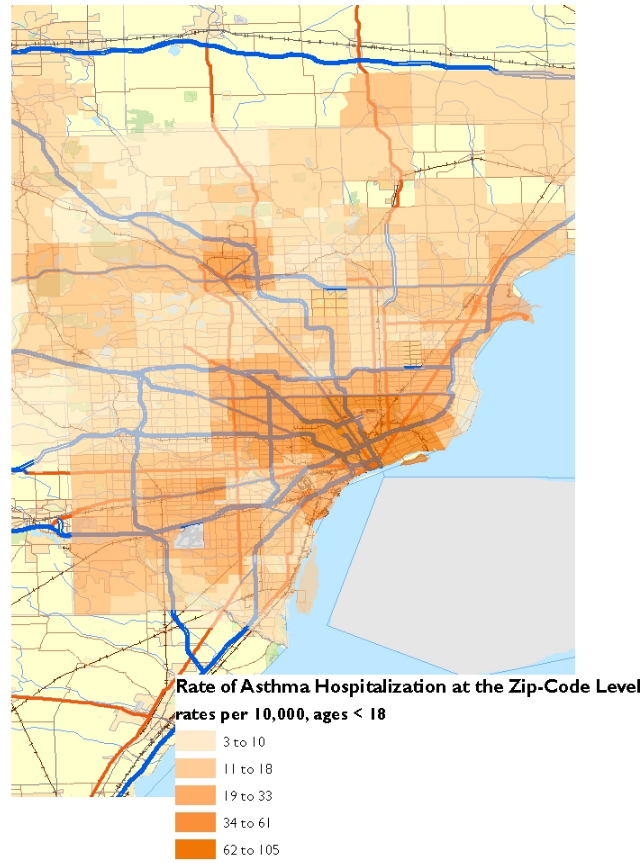


Certain Incidence Rates are Highly Correlated with Subpopulations

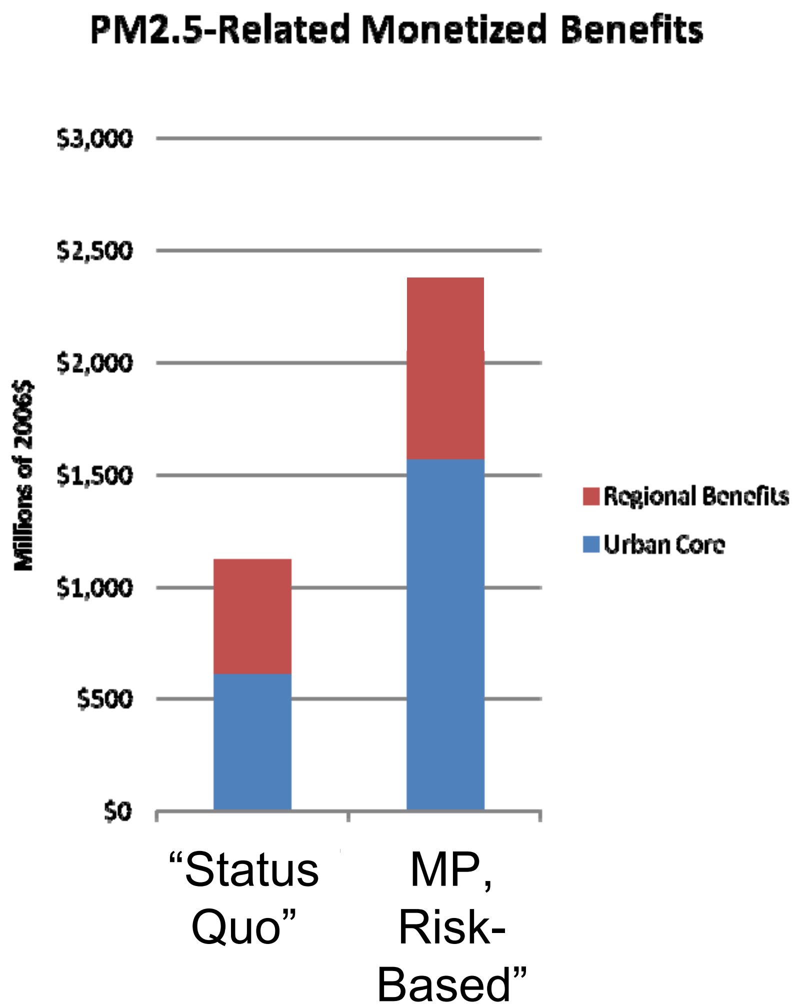
African-American Population

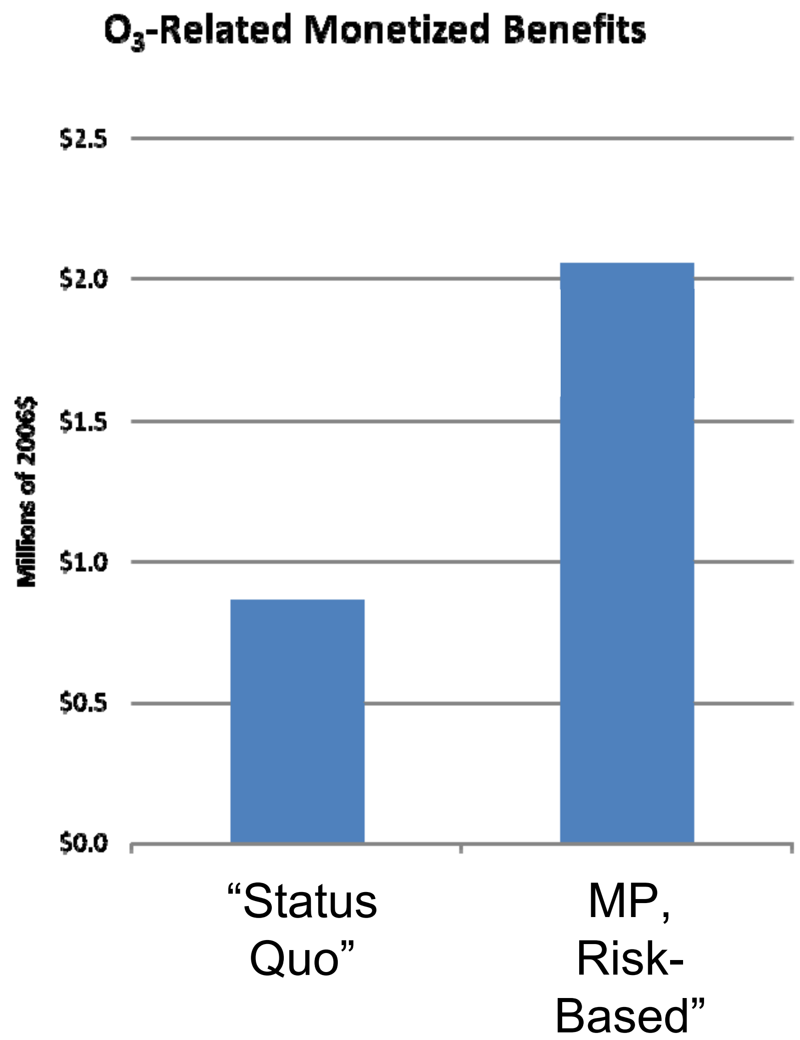


Asthma Hospitalization Rate



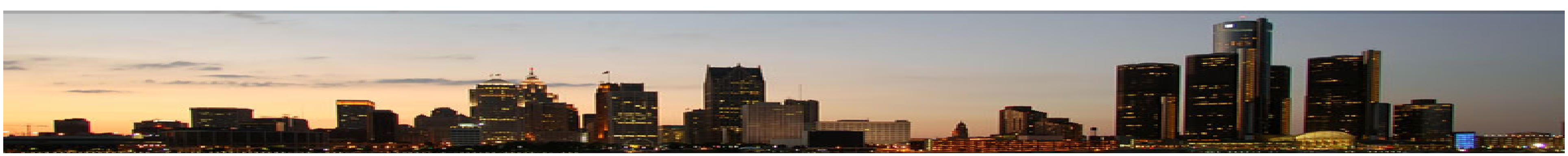
Health Benefits of “Status Quo” vs “MP, Risk-Based” Control Strategy





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

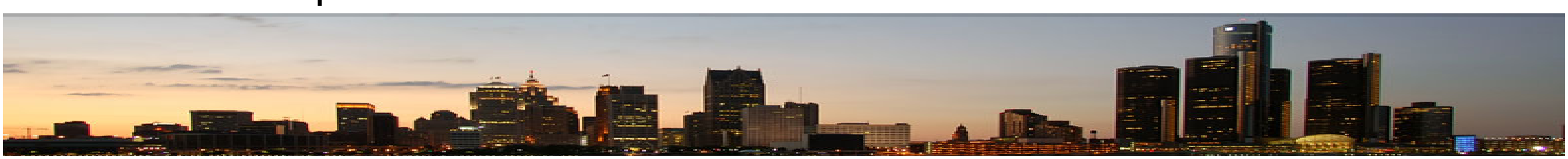
Cancer

- 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

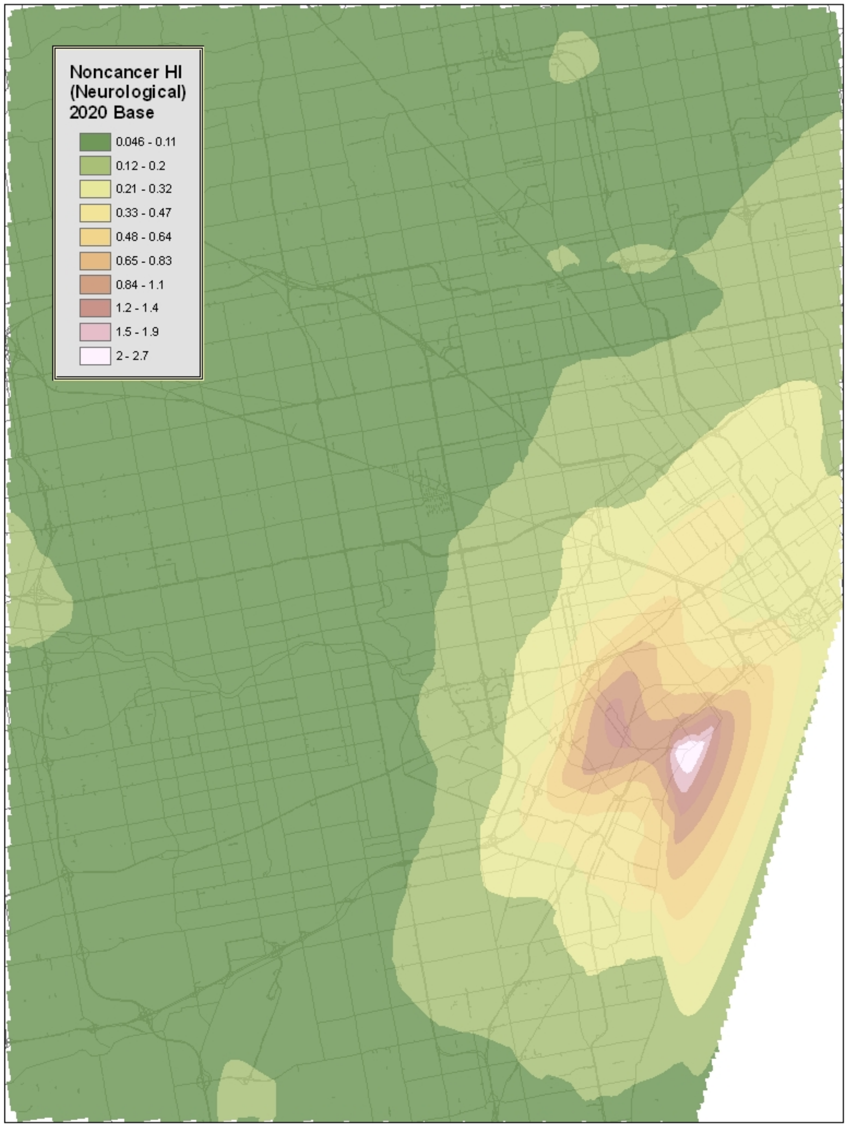
NonCancer

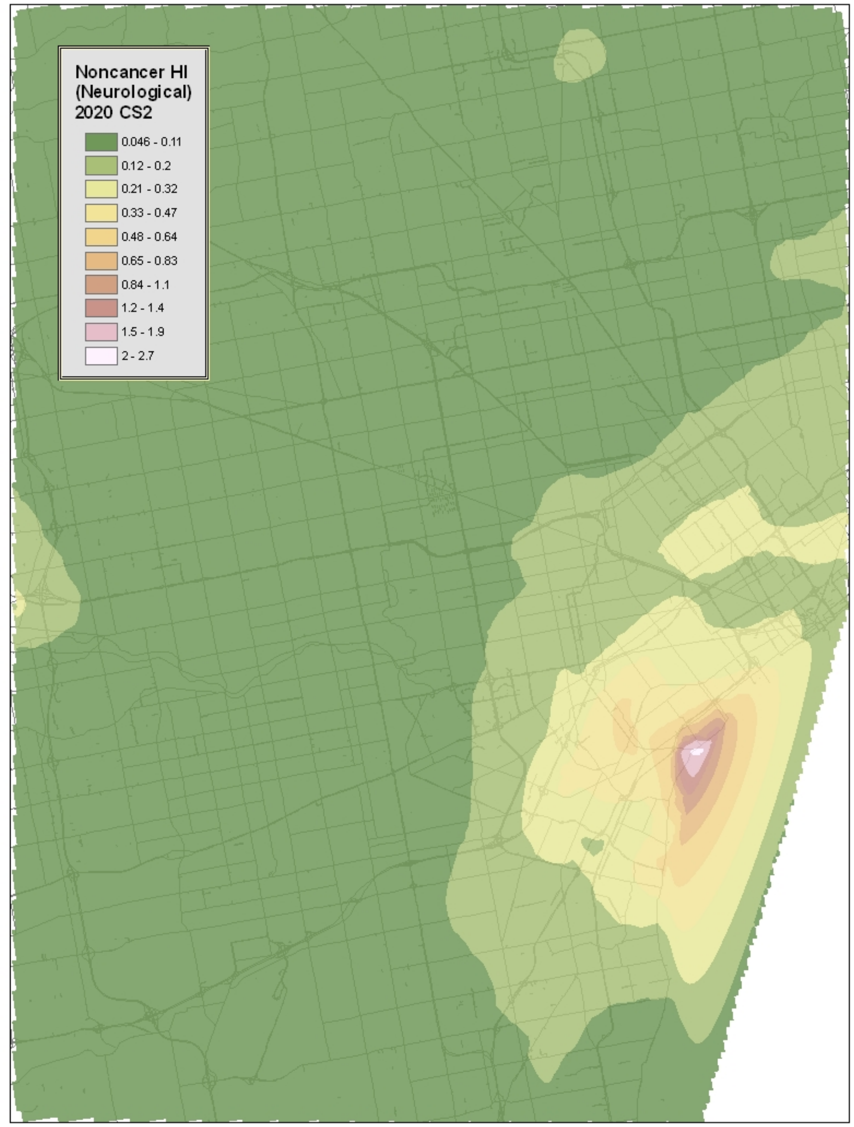
- Max hazard index lower for "MP,Risk-Based" Strategy
  - 2 ("MP, Risk-Based") vs 3 ("Status Quo") vs 3 for 2020 Base
  - About 30% fewer people above HI of 1 due to reductions of Manganese

→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

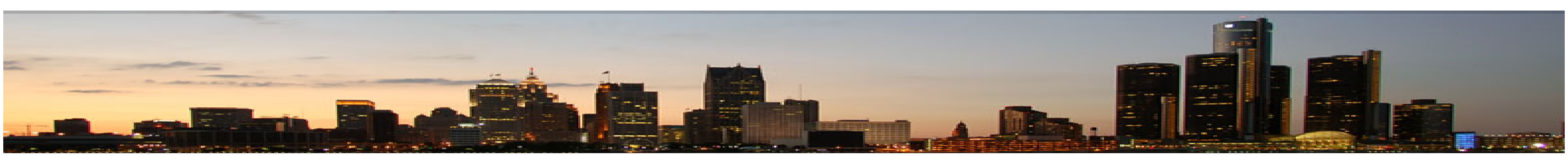




Criteria 5:
Net Benefits
& Cost Effectiveness

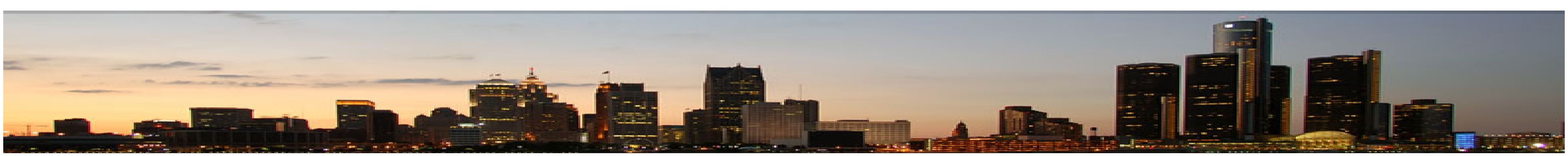
Benefit-Cost Comparison

		"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



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