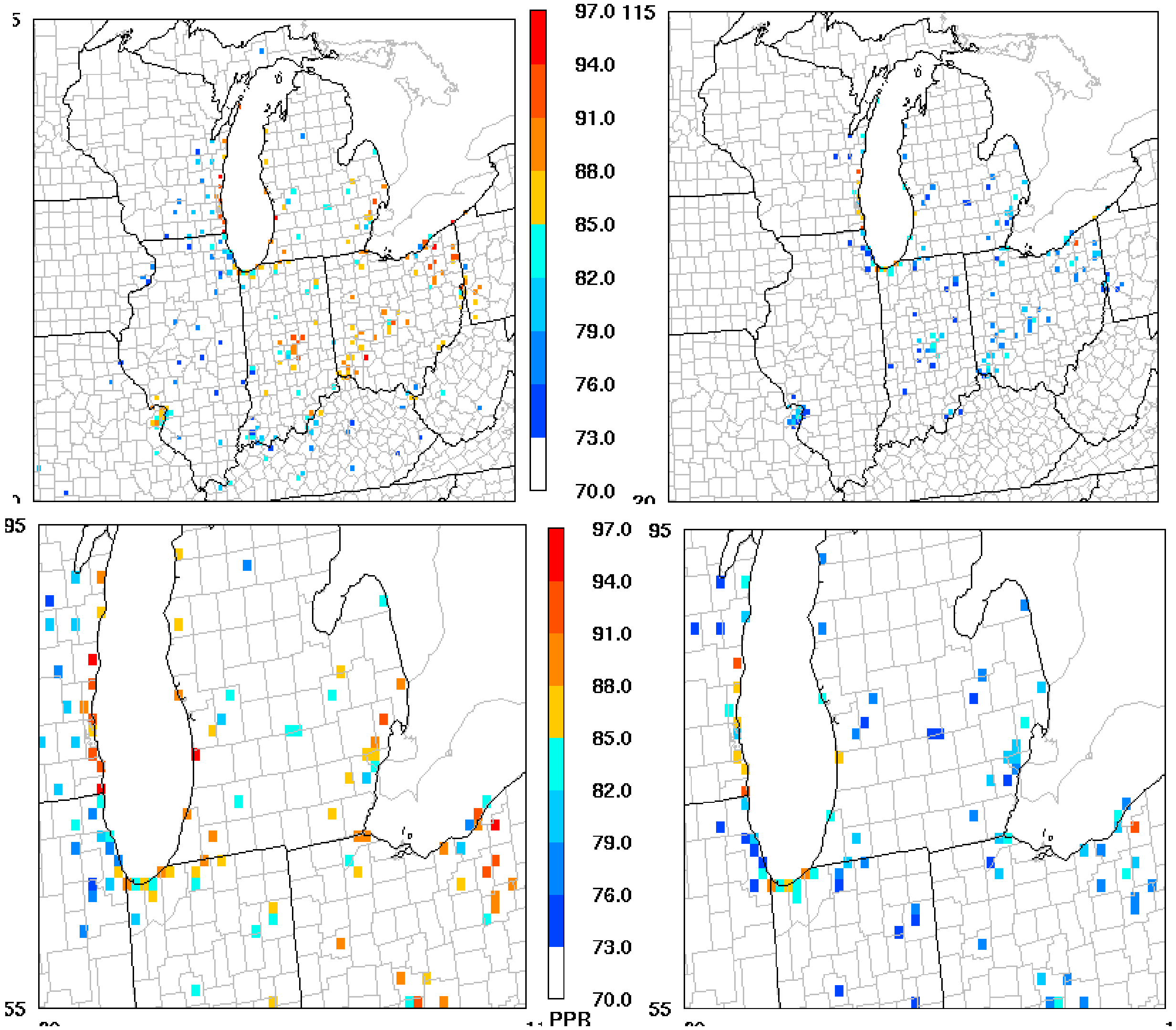
Round 3 Strategy Modeling

The purpose of this document is to summarize the results of the Round 3 strategy modeling. The Round 3 strategies are identified in Table 1. This round of modeling reflects several notable updates from the previous round of modeling: (1) updated IPM projections for power plants, (2) consideration of additional future years (i.e., 2012 and 2015), and (3) use of 12 km emissions and meteorology for summer ozone modeling.

The observed base year (2002) and modeled future year (2009) design values (Strategy 2) for ozone and $PM_{2.5}$ are shown in Figure 1 and Table 2. As can be seen, the modeling shows that existing control programs, including CAIR will provide considerable improvement in air quality for ozone and $PM_{2.5}$, but will not be enough to provide for attainment everywhere by 2009.



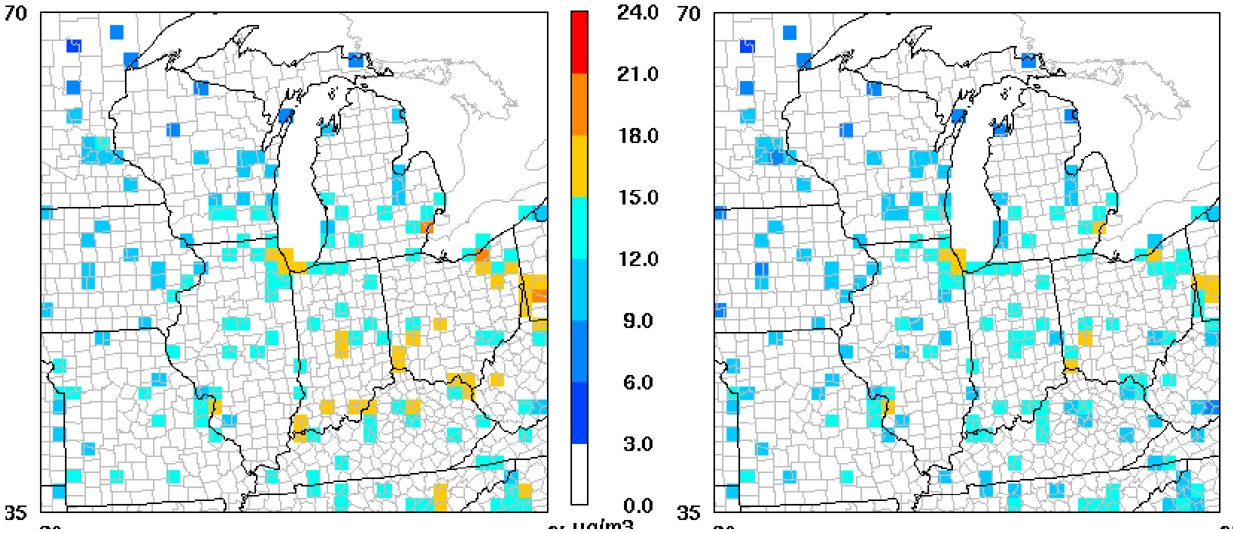


Figure 1. Observed base year (left) v.projected future year (right) design values for ozone (top two rows) and $PM_{2.5}$ (bottom row)

The residual nonattainment areas include the Lake Michigan area and Cleveland for ozone, and Chicago, Granite City, Detroit, Cincinnati, and Cleveland for $PM_{2.5}$ (see Figure 2).

Ozone **$PM_{2.5}$**

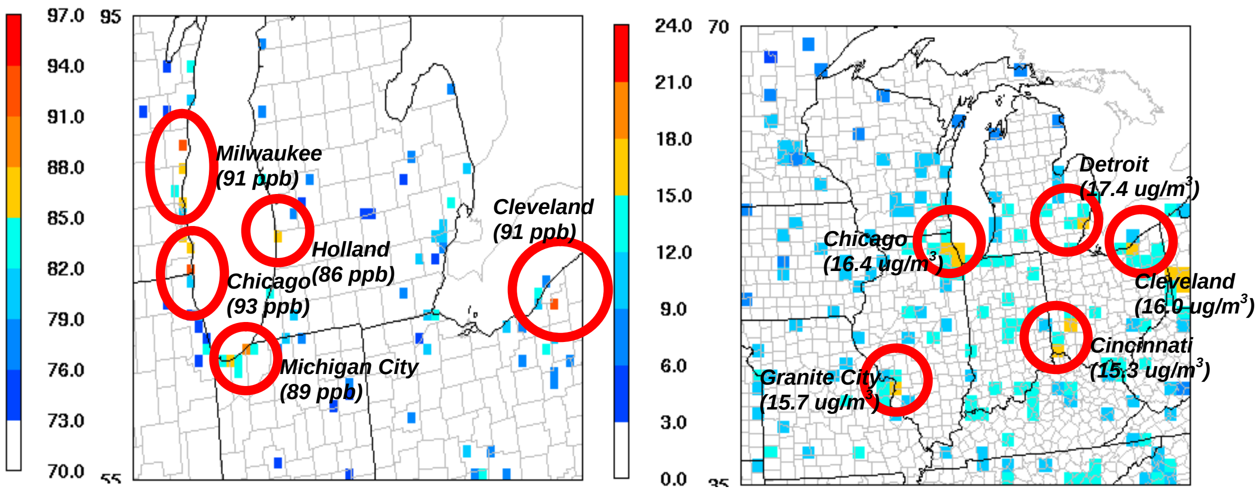


Figure 2. 2009 Projected Nonattainment Areas for Ozone (left) and $PM_{2.5}$ (right)

The attainment test was applied consistent with USEPA's draft ozone and $PM_{2.5}$ modeling guidance. The "base" year design value was based on the weighted average of the design values for three 3-year periods (2000-2002, 2001-2003, and 2002-2004), and the relative reduction factors were calculated using the same grid cell as the monitor and, for ozone, assuming a threshold of 70 ppb.

These modeling results are qualitatively similar to those produced by USEPA for their final CAIR rulemaking (see "Technical Support Document for the Final Clean Air Interstate Rule, Air Quality Modeling", March 2005). A county-level comparison of the projected future year design values is provided in Table 3. Numerical differences are attributable to different base year design values, meteorological data, and future projection periods (i.e., 2002-2009 v. 2001-2010).

Table 1. Round 3 Strategy Modeling Runs

Run		Description		2002	2009	2012	2015	2018
Base J		2002 baseyear emissions inventory		x*				
~~Scenario 1~~		~~"On the books" controls~~			~~x*~~			
Scenario 2		a. "On the books" controls plus CAIR (based on IPM)			x*	x*	x	x
Scenario 4		c. EGU2 in LADCO States			x*	x*		
		d. EGU2 in 12-state region (LADCO States plus MN, IA, MO, KY, TN, WV, PA)			x*	x*		
Scenario 6		Scenario 2 plus BART for non-EGU sources in LADCO States plus MN and ND						x
		EGU1= 2009 - SOx:0.36 lb/MMBTU, NOx: 0.15 lb/MMBTU			** = additional 12 km run*			
		2013 - SOx:0.15 lb/MMBTU, NOx: 0.10 lb/MMBTU						
		EGU2= 2009 - SOx:0.24 lb/MMBTU, NOx: 0.12 lb/MMBTU						
		2013 - SOx:0.10 lb/MMBTU, NOx: 0.07 lb/MMBTU						

Table 2. Round 3 Modeling Results

$PM_{2.5}$ Design Values		Observed	2009CAIR	2009-4c	2009-4d	2012CAIR	2012-4c	2012-4d	2015CAIR	2018CAIR	2018BART
Chicago	170310014	15.6	14.7								
	170310022	15.9	15.1			14.8	14.4	14.2	14.9	14.6	14.4
	170310050	15.5	14.6								
	170310052	17.1	16.4			16.1	15.7	15.5	16.0	15.8	15.6
	170310057	15.6	14.8								
	170310076	15.5	14.6								
	170312001	15.6	14.8								
	170313103	16.0	15.5			15.2	14.9	14.7	15.1	14.9	14.7
	170313301	16.0	15.1			14.9	14.4	14.2	14.9	14.7	14.4
	170314006	15.3	14.8								
	170316005	16.4	15.5			15.3	14.9	14.7	15.3	15.1	14.9
Granite City	171191007	17.3	15.7			15.3	15.1	14.7	15.2	15.0	14.8
	171630010	16.2	14.7								
Clark County	180190005	16.3	14.0								
	180190006	16.5	14.1								
Dubois Cty	180372001	15.8	13.5								
Lake County	180891016	15.7	14.8								
Indianapolis	180970078	16.2	14.5								
	180970079	15.5	13.7								
	180970081	16.0	14.7								
	180970083	16.4	14.7								
Detroit	261630001	15.9	14.7								
	261630015	17.3	15.9			15.4	14.8	14.7	15.0	14.5	14.4
	261630016	15.4	14.2								
	261630033	18.9	17.4			16.9	16.2	16.1	16.4	15.9	15.7
	261630036	17.8	16.5			16.0	15.3	15.2	15.5	15.0	14.9
Butler County	390170003	16.1	14.1								
	390170016	15.7	13.6								
	390170017	15.4	13.5								
Cleveland	390350013	17.3	15.1			14.5	14.0	13.8	14.0	13.5	13.4
	390350027	16.7	14.6								
	390350038	18.4	16.0			15.4	14.9	14.7	14.9	14.4	14.3
	390350044	16.7	14.6								
	390350060	17.5	15.3			14.7	14.1	14.0	14.2	13.7	13.6
	390350065	16.1	14.1								
Columbus	390490024	16.6	14.3								
	390490025	16.0	13.8								
	390490081	15.9	13.8								
Cincinnati	390610014	17.7	15.3			14.7	14.0	13.7	14.3	13.8	13.7
	390610040	15.6	13.5								
	390610041	15.3	13.2								
	390610042	17.1	14.8								

	390610043	15.8	13.6								
	390617001	16.2	14.0								
	390618001	17.1	14.8								
Jefferson	390810016	17.9	13.3								
	390811001	17.5	13.0								
Lawrence	390870010	15.6	12.5								
Dayton	391130014	17.9	15.9			15.3	14.6	14.3	14.8	14.3	14.2
	391130031	15.1	13.3								
	391130032	15.7	13.8								
Scioto	391450013	16.5	13.6								
Canton	391510017	17.3	14.8								
	391510020	15.7	13.4								
Summit	391530017	16.4	14.1								
	391530023	15.4	13.2								
O_3 Design Values		**Observed**	**2009CAIR**	**2009-4c**	**2009-4d**	**2012CAIR**	**2012-4c**	**2012-4d**	**2015CAIR**	**2018CAIR**	
Chicago	170310032	85.3	83.4								
NW Indiana	180890022	82.0	83.8								
	180892008	88.3	90.2	89.8	89.6	91.7	86.4	86.2	93.0		
	180910005	90.3	89.5	89.0	88.8	89.9	85.3	85.4	89.9		
	180910010	85.5	83.0								
	181270024	86.3	87.8	87.4	87.2	88.7	83.6	83.5	89.1		
Indianapolis	180571011	93.7	84.8								
Holland	260050003	94.0	86.2	85.6	85.4	85.4	84.5	84.4	84.5		
Muskegon	261210039	90.0	83.3								
Detroit	260990009	92.3	84.3								
Cleveland	390071011	95.7	87.0	86.3	86.1	85.9	84.8	84.7	84.0		
	390550004	99.0	91.2	90.8	90.5	90.0	88.6	88.4	89.3		
	390850003	92.7	84.7								
Columbus	390490029	93.0	84.3								
Akron	391530020	93.3	84.0								
Cincinnati	390610006	90.3	83.2								
Toledo	390950034	90.0	83.6								
Kenosha	550590002	96.0	90.6	90.3	90.1	90.8	91.6	91.5	91.3		
	550590019	98.3	92.8	92.5	92.3	93.0	93.8	93.7	93.5		
Milwaukee	550790085	91.0	86.5	86.2	86.1	86.9	85.3	85.2	87.3		
	550791025	91.0	86.3	86.1	86.0	86.4	85.1	85.0	86.6		
Kewaunee	550610002	89.3	83.1								
Ozaukee Cty	550890009	93.0	87.3	87.0	86.8	87.5	86.8	86.7	87.6		
Racine	551010017	91.7	86.0	85.8	85.6	86.0	86.5	86.4	86.1		
Sheboygan	551170006	97.0	91.2	90.9	90.7	91.1	90.9	90.8	90.7		
Door County	550290004	91.0	83.2								

Table 3. LADCO v. USEPA Modeling Results (Projected Nonattainment Sites)

			Ozone			PM2.5	
State	**County**		**LADCO**	**USEPA**		**LADCO**	**USEPA**
IL	Cook					*16.4*	*16.9*
	Madison					*15.7*	*16.1*
	St. Clair					14.7	*15.6*
IN	Lake		*89.8*	82.8		11.0	*16.4*
	LaPorte		*89.0*	81.8			
	Marion					14.7	*15.4*
	Porter		*87.4*	81.1			
MI	Allegan		*86.2*	82.1			
	Macomb		84.3	*85.4*			
	Wayne					*17.4*	*17.9*
OH	Ashtabula		*87.0*	83.5			
	Cuyahoga					*16.0*	*16.7*
	Geauga		*91.2*	*86.6*			
	Hamilton					*15.3*	*16.1*
	Jefferson					13.3	*15.2*
	Scioto					13.6	*15.5*
WI	Kenosha		*92.8*	*91.0*			
	Milwaukee		*86.5*	82.1			
	Ozaukee		*87.3*	*85.8*			
	Racine		*86.0*	83.9			
	Sheboygan		*91.2*	*87.7*			

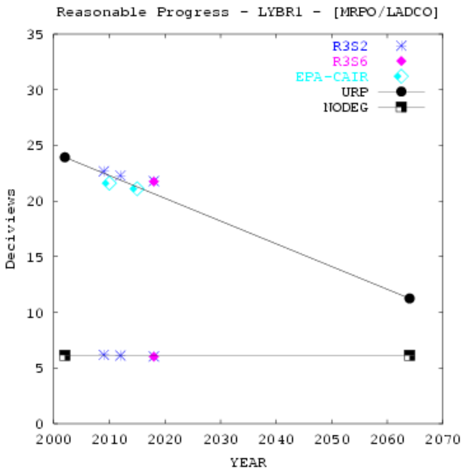
For many of the residual nonattainment monitors, culpability information was developed using the OSAT and PSAT algorithms in CAMx (see "Ozone, $PM_{2.5}$, and Regional Haze Culpability Analyses", October 7, 2005). These analyses show that the largest impacts on ozone or $PM_{2.5}$ nonattainment, as well as visibility impairment, are from on-road NOx emissions (ozone, PM-nitrate), and EGU and non-EGU SO2 emissions (PM-sulfate) from the same or neighboring state(s) (i.e., closer states have more impact than distant states). (Note information on sources of organic carbon is expected shortly from the Urban Organics Study.)

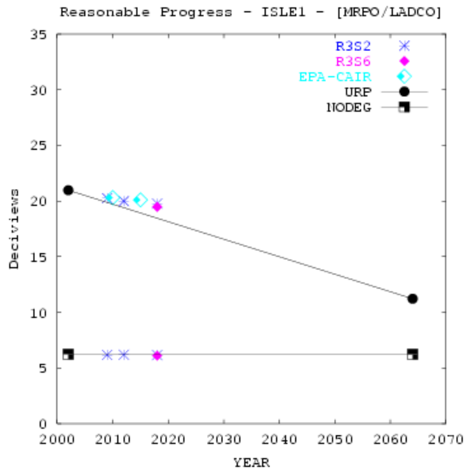
The modeling also shows that the existing control programs, including CAIR and BART will improve visibility, but will not be enough to meet regional haze goals in the northern Class I areas (see Table 4). Figure 3 shows that the resulting visibility levels in 2018 in these Class I areas are above the uniform rate of progress line.[1]

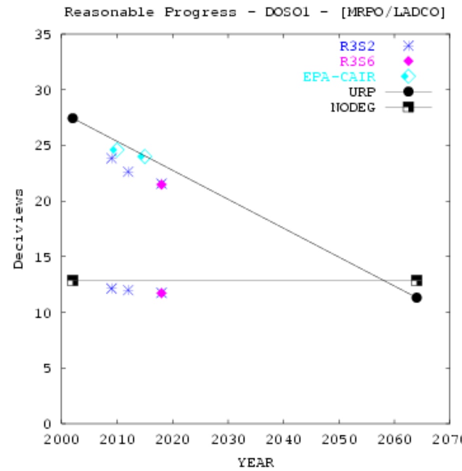
Table 4. Model Visibility Results for 20% Worst Visiblity Days

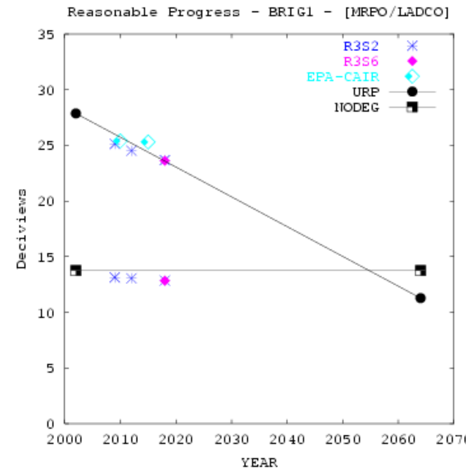
Site	Type	DV	Goal	2009S2	2012S2	**2018S2**	**2018S6**
BOWA1	Worst 20%	20.07	17.78	19.46	19.37	**19.32**	**18.77**
VOYA2	Worst 20%	18.7	16.74	18.66	18.61	**18.54**	**18.13**
ISLE1	Worst 20%	20.97	18.45	20.25	19.98	**19.77**	**19.48**
SENE1	Worst 20%	23.83	20.61	22.81	22.56	**22.26**	**22.03**
MING1	Worst 20%	27.7	23.46	25.08	24.51	**23.82**	**23.69**
MACA1	Worst 20%	30.1	25.31	27.01	26.04	**24.62**	**24.5**
DOSO1	Worst 20%	27.44	23.28	23.84	22.63	**21.57**	**21.47**
SHEN1	Worst 20%	27.89	23.6	23.98	22.94	**21.87**	**21.77**
LYBR1	Worst 20%	23.93	20.66	22.67	22.29	**21.79**	**21.75**
BRIG1	Worst 20%	27.87	23.59	25.13	24.52	**23.67**	**23.61**

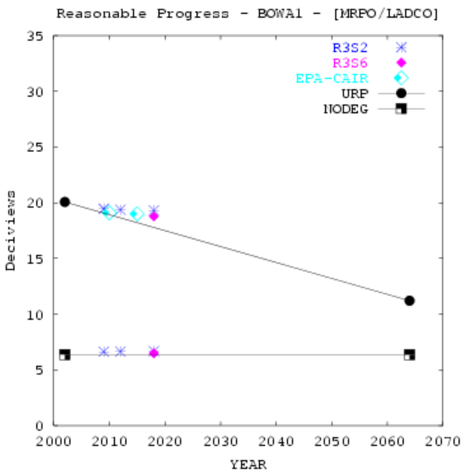
[1] The haze requirement is to achieve reasonable progress by 2018 (i.e., the first milestone year for haze). A determination of reasonable progress for a given strategy is to be based on four statutory factors (i.e., costs, timing, energy impacts, and remaining useful life for the affected sources), as well as how the resulting visibility level compares with the uniform rate of progress. Only the comparison with the uniform rate of progress line is addressed here.

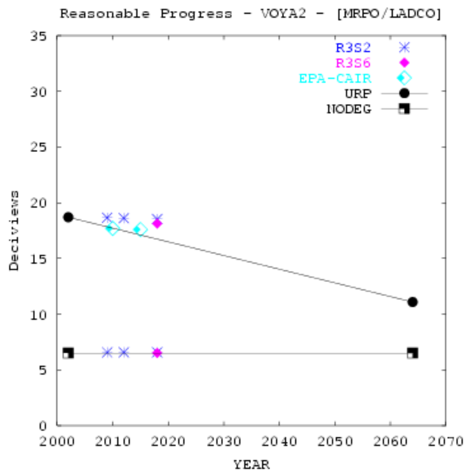


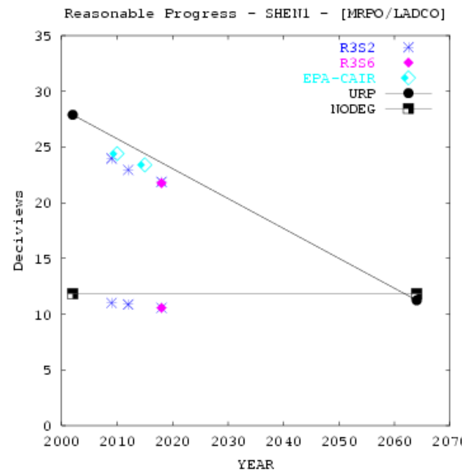


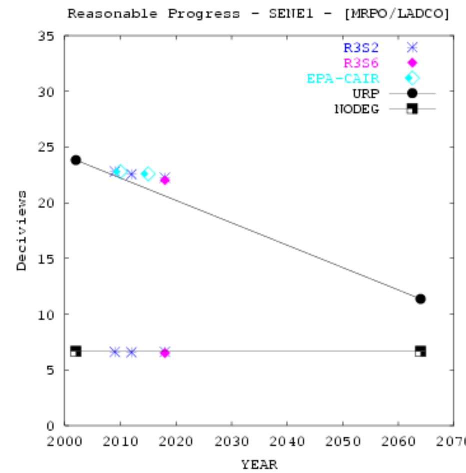


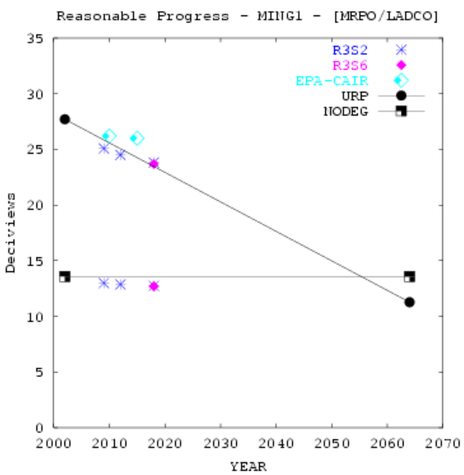












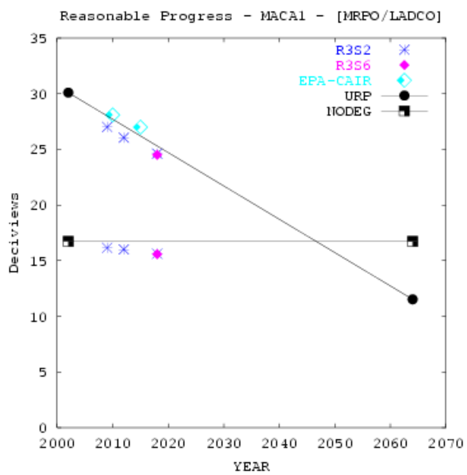


Figure 3. Visibility Levels in Nearby Class I Area

Sensitivity modeling results from Round 2 were used to estimate the emission reduction targets in the residual ozone and $PM_{2.5}$ nonattainment areas. Based on this information, several example emission reduction scenarios were identified (see Table 5).

Ambient data analyses provide further directional information on appropriate control strategies. The results of these analyses are summarized below:

- Regional NOx emission reductions and local (urban-scale) VOC emission reductions will be effective in lowering ozone concentrations

  (see “VOC and NOx Limitation of Ozone Formation at Monitoring Sites in Illinois, Indiana, Michigan, Missouri, Ohio, and Wisconsin, 1998-2002, C.Blanchard and S.Tanenbaum, February 24, 2004)

- Regional NOx emission reductions will be effective in lowering PM-nitrate concentrations, and regional SO2 emission reductions will be effective in lowering PM-sulfate concentrations

  (see “Draft Final Technical Memorandum, Analysis of Data from the Midwest Ammonia Monitoring Project”, C. Blanchard and S.Tanenbaum, March 31, 2005; and “The Effects of Changes in Sulfate, Ammonia, and Nitric Acid on Fine PM Composition at Monitoring Sites in Illinois, Indiana, Michigan, Missouri, Ohio, and Wisconsin, 2000-2002”, C.Blanchard and S.Tanenbaum, February 20, 2004)

Based on this information, reductions on the order of 25 – 35% each for NOx, SO2, VOC, and OC (beyond the reductions in 2009 from existing control programs, including CAIR) may be a reasonable starting point for the policy discussions. SO2 and NOx reductions are most effective on a regional basis, while OC and VOC reductions are most effective on a local basis. Adjustment of this reduction target may be appropriate following discussion of the achievable emission reductions for each pollutant, the source sectors to be controlled, the geographic coverage of the controls, and the compliance date.

Table 5. Example Emission Reduction Scenarios
(% Reduction from 2009 CAIR Emissions)

				Local VOC (orOC)*	Regional NOx*	Regional SO2*
Chicago	Ozone	(1)		>75	----	
		(2)		----	40	
		(3)		35	35	
	PM2.5	(1)		40	----	----
		(2)		30	30	----
		(3)		25	25	25
		(4)		----	50	50
Milwaukee	Ozone	(1)		>75		
		(2)		----	30	
		(3)		25	25	
Granite City	PM2.5	(1)		30	----	----
		(2)		25	25	----
		(3)		20	20	20
		(4)		----	25	50
		(5)		----	50	25
Detroit**	PM2.5	(1)		50	----	----
		(2)		30	30	----
		(3)		25	25	25
		(4)		----	50	50
Cincinnati	PM2.5	(1)		15	15	----
		(2)		10	10	10
		(3)		----	15	15
Cleveland	Ozone	(1)		>75	----	
		(2)		----	30	
		(3)		25	25	
	PM2.5	(1)		40	----	----
		(2)		25	25	----
		(3)		20	20	20
		(4)		----	25	50
		(5)		----	50	25
Isle Royale/	Visibility	(1)		----	10	50
Seney						

* Local generally means the nonattainment counties, although some controls may be effective in surrounding counties. Regional means throughout the 5-state LADCO area. It should be noted that comparable air quality benefits can be achieved at lower control levels (than those identified here) if the control area is expanded beyond the 5-state area

** The example scenarios presented here for Detroit were derived based on the second highest monitoring site in southeastern Michigan. The highest monitoring site (Dearborn) is influenced by local sources and will require significant additional local source reductions to achieve attainment.