

Treatment of Non-market Benefits in REMI Model



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Socioeconomic Analysis

South Coast Air Quality Management District

REMI Webinar

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South Coast AQMD purpose

- **Control air pollution to protect public health**
 - ❑ Jurisdiction: Urban portions of Los Angeles, Riverside, and San Bernardino counties, along with all of Orange County.
 - ❑ Regulate air pollutant emissions, mostly from stationary sources.



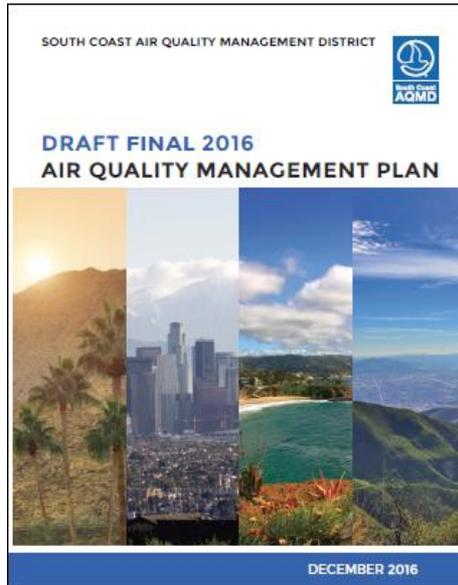
Sources

Air Quality

Health

South Coast AQMD pollution control process/methods

Air Quality Management Plan



Regulations & Incentives (Sticks and Carrots)



Public Outreach & Enforcement

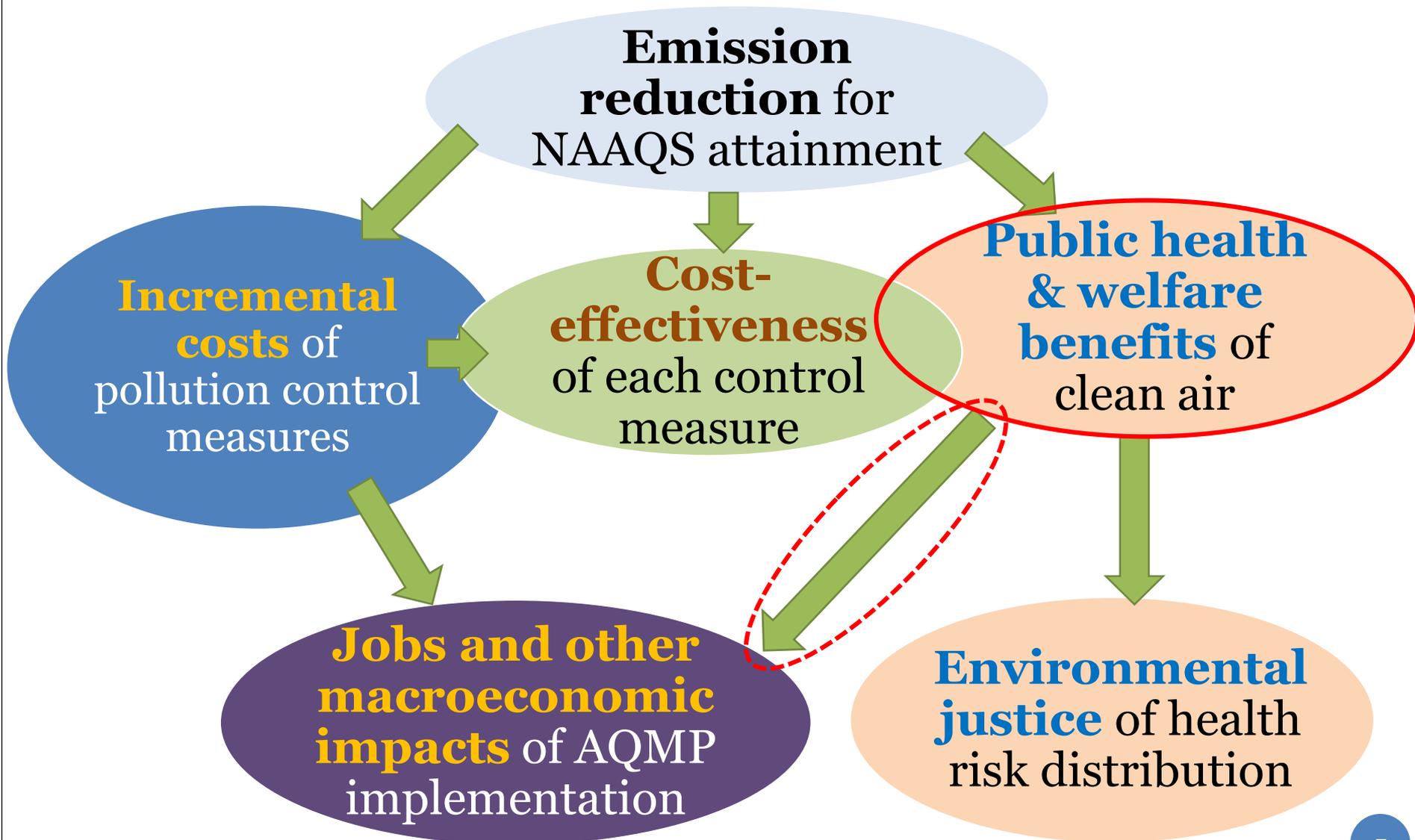


Air Quality Management Plan

- South Coast AQMD Air Quality Management Plan (AQMP) - Regional blueprint for attaining federal air quality standards in South Coast Air Basin and Coachella Valley, which are home to about 17 million people.



AQMP socioeconomic analysis



Public health benefits of AQMP - estimation

- AQMP implementation improves local air quality.
 - Less ozone formation and particulate matter emitted.
- Reduced mortality and morbidity (e.g. asthma, bronchitis, stroke, etc.).
- Use EPA's BenMAP software to estimate health impacts and value them monetarily.

Health impact function

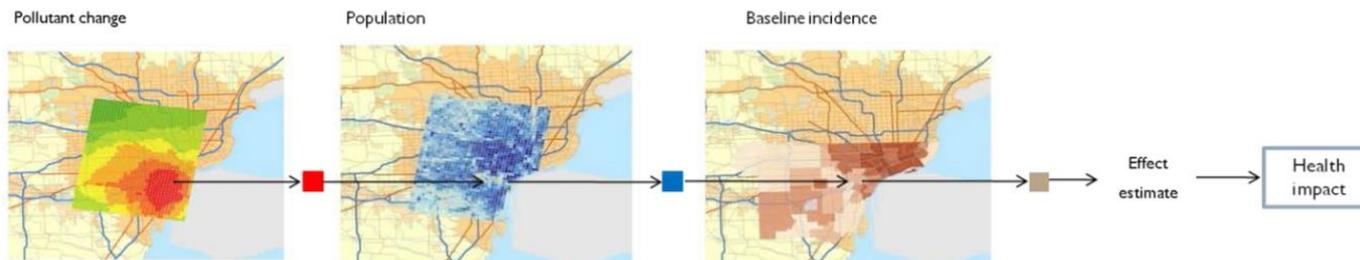
$$\Delta Y = Y_0 (1 - e^{-\beta \Delta PM}) * Pop$$

Y_0 - Baseline Incidence

β - Effect estimate

ΔPM - Air quality change

Pop - Exposed population



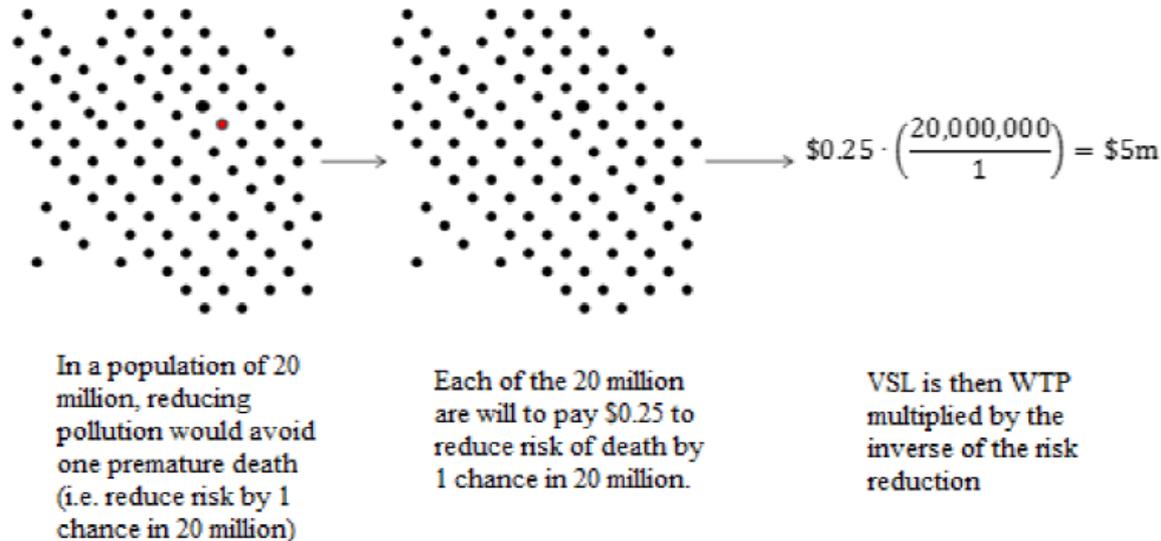
2016 AQMP estimated health effects

Endpoint	2023	2031	Average Annual (2017-2031)
Premature Deaths Avoided, All Cause			
Short-Term Ozone Exposure	45	89	49
Long-Term PM2.5 Exposure	1,394	2,716	1,512
Short-Term PM2.5 Exposure	100	194	108
Reduced Morbidity Incidence			
Short-Term Ozone Exposure			
Emergency Room Visits, Asthma	2,209	4,154	2,350
Hospital Admissions (HA), All Respiratory	68	148	78
Hospital Admissions (HA), Asthma	64	119	68
Minor Restricted Activity Days	327,312	610,075	346,679
School Loss Days, All Cause	100,034	184,781	105,451
Long-Term PM2.5 Exposure			
Acute Bronchitis	1,039	1,890	1,087
Short-Term PM2.5 Exposure			
Acute Myocardial Infarction, Nonfatal	33	71	38
Asthma Exacerbation (Wheeze, Cough, Shortness of Breath)	23,321	42,780	24,495
Asthma, New Onset (Wheeze)	2,956	5,577	3,151
HA, All Cardiovascular (less Myocardial Infarctions)	164	337	183
HA, All Respiratory (less Asthma)	136	290	155
HA, Ischemic Stroke	79	171	91
HA and ED Visits, Asthma	142	260	149
Lower Respiratory Symptoms	12,268	22,387	12,850
Upper Respiratory Symptoms	24,342	44,720	25,587
Minor Restricted Activity Days	528,869	961,248	552,809
Work Loss Days	91,689	166,826	95,892

Public health benefits - monetization

- **Mortality: Value of statistical life (VSL)**

- Based on willingness-to-pay (WTP) estimates for small health risk reduction. Used VSL of \$9 million (2013\$).



Source: U.S. EPA, modified by Industrial Economics, Inc. and SCAQMD staff

- **Morbidity: Mainly cost of illness (COI) avoided**

- Reduced direct healthcare cost and reduced indirect cost due to reduced productivity caused by illness (e.g. fewer work days lost and fewer school days missed).

Monetized 2016 AQMP public health benefits

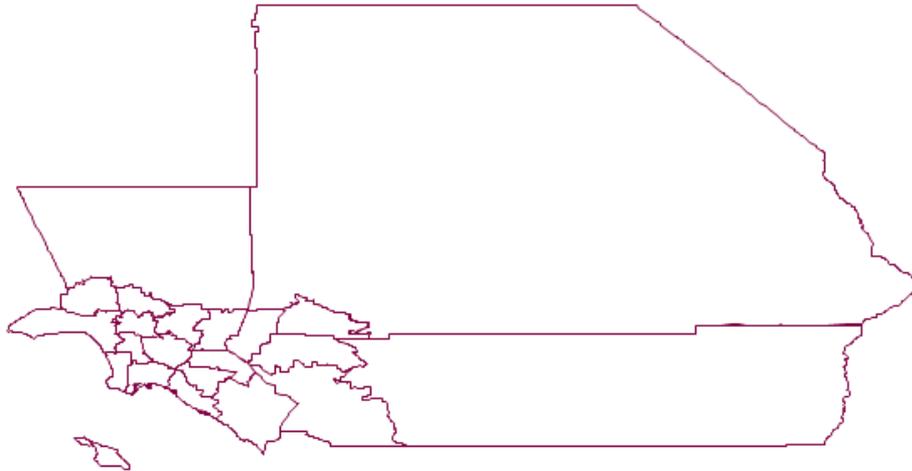
- Based on reduced mortality and morbidity risks resulting from implementing proposed control measures
 - Over 95 percent associated with avoided premature deaths from reduced long-term exposure to PM_{2.5}.



	Year 2023	Year 2031	Average Annual (2017-2031)	Present Value (2017-2031)
Mortality-related benefits	\$14.2	\$30.5	\$16.2	\$170.8
<i>Short-Term Ozone Exposure</i>	\$0.5	\$1.1	\$0.6	\$6.1
<i>Long-Term PM_{2.5} Exposure</i>	\$13.7	\$29.4	\$15.7	\$164.7
Morbidity-related benefits	\$0.2	\$0.4	\$0.2	\$2.4
Grand Total	\$14.4	\$30.9	\$16.5	\$173.2

REMI: South Coast AQMD model

- South Coast AQMD uses regional economic impact model REMI PI+ tailored to South Coast AQMD four-county region based on 21 sub-county regions.



- The REMI model simulates many macroeconomic variables including jobs, output, cost of production, and value-added by sector.

REMI: Public health benefits – morbidity

- BenMAP provides monetary values of health effects.
 - REMI-model practitioner needs to determine how to input these monetized health benefits into REMI.
- Reduced morbidity expected to result in changes in consumer spending:
 - Reduced consumer spending on healthcare.
 - Increased consumer spending on other goods and services, and increased savings.

REMI: Reduced morbidity reduces healthcare spending (v1.7 REMI)

Policy Variable Inputs

Active	Edit	Category			Notes							
<input checked="" type="checkbox"/>		Composite (126 PV-s)			Reduced Consumer Spending on healthcare industries							
Active	Items			PV Id		2014	2015	2016	2017	2018	2019	2020
	Category	Detail	Region	Unit Code	Variable Number							
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Beach & Catalina	2015 Chain	643	0	0	0	-6.94691E-	-0.0001418	-0.0002166	-0.0002907
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Burbank	2015 Chain	643	0	0	0	-5.35645E-	-0.0001096	-0.0001677	-0.0002259
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Central	2015 Chain	643	0	0	0	-0.0002421	-0.0004964	-0.0007634	-0.0010403
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	North	2015 Chain	643	0	0	0	-1.86148E-	-3.84661E-	-5.96614E-	-8.27653E-
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	San Fernando	2015 Chain	643	0	0	0	-0.0001285	-0.0002632	-0.0004045	-0.0005507
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	San Gabriel Valley E	2015 Chain	643	0	0	0	-8.25709E-	-0.0001689	-0.0002591	-0.0003496
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	San Gabriel Valley V	2015 Chain	643	0	0	0	-0.0001568	-0.0003207	-0.0004902	-0.0006599
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	South	2015 Chain	643	0	0	0	-0.0001016	-0.0002078	-0.0003177	-0.0004271
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	South Central	2015 Chain	643	0	0	0	-0.0001708	-0.0003497	-0.0005367	-0.0007280
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Southeast	2015 Chain	643	0	0	0	-0.0002039	-0.0004166	-0.0006371	-0.0008573
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	West	2015 Chain	643	0	0	0	-0.0001397	-0.0002860	-0.0004398	-0.0005988
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Orange Central	2015 Chain	643	0	0	0	-0.0001159	-0.0002370	-0.0003635	-0.0004909
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Orange North	2015 Chain	643	0	0	0	-5.24776E-	-0.0001074	-0.0001648	-0.0002230
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Orange South	2015 Chain	643	0	0	0	-6.41891E-	-0.0001325	-0.0002049	-0.0002803
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Orange West	2015 Chain	643	0	0	0	-7.69143E-	-0.0001571	-0.0002407	-0.0003247
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Northwest Riversid	2015 Chain	643	0	0	0	-9.7319E-5	-0.0002003	-0.0003084	-0.0004165
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Riverside Other	2015 Chain	643	0	0	0	-1.71792E-	-3.5545E-5	-5.50412E-	-7.52371E-
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Riverside Southwe	2015 Chain	643	0	0	0	-3.81203E-	-7.87853E-	-0.0001219	-0.0001674
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	San Bernardino Cit	2015 Chain	643	0	0	0	-8.10634E-	-0.0001662	-0.0002554	-0.0003449
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	Other San Bernard	2015 Chain	643	0	0	0	-1.4489E-5	-2.97733E-	-4.58795E-	-6.25881E-
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Hospitals	San Bernardino Sou	2015 Chain	643	0	0	0	-8.12052E-	-0.0001671	-0.0002578	-0.0003502
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	Beach & Catalina	2015 Chain	661	0	0	0	-1.12935E-	-2.30641E-	-3.52178E-	-4.72711E-
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	Burbank	2015 Chain	661	0	0	0	-8.7079E-6	-1.78187E-	-2.72649E-	-3.67354E-
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	Central	2015 Chain	661	0	0	0	-3.93623E-	-8.07058E-	-0.0001241	-0.0001691
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	North	2015 Chain	661	0	0	0	-3.02619E+	-6.25338E+	-9.69907E+	-1.3455E-5
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	San Fernando	2015 Chain	661	0	0	0	-2.08987E-	-4.27945E-	-6.57603E-	-8.95339E-
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	San Gabriel Valley E	2015 Chain	661	0	0	0	-1.34234E-	-2.74582E-	-4.21317E-	-5.68442E-
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	San Gabriel Valley V	2015 Chain	661	0	0	0	-2.54966E-	-5.21404E-	-7.96958E-	-0.0001072
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	South	2015 Chain	661	0	0	0	-1.65286E-	-3.37968E-	-5.16594E-	-6.94463E-
<input checked="" type="checkbox"/>	Consumer Spending (amount)	Net health insurance	South Central	2015 Chain	661	0	0	0	-2.77794E-	-5.68612E-	-8.72581E-	-0.0001183

REMI: Reduced morbidity increases non-healthcare spending

Policy Variable Inputs

Active	Edit	Category	Notes
<input checked="" type="checkbox"/>		Composite (126 PV-s)	Reduced Consumer Spending on healthcare industries
<input checked="" type="checkbox"/>		Composite (21 PV-s)	Reallocation of reduced healthcare spending

Items				PV Id		2014	2015	2016	2017	2018	2019	2020
Active	Category	Detail	Region	Unit Code	Variable Number							
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Beach & Catalina	2015 Chain	78	0	0	0	0.0001849	0.0003776	0.0005766	0.0007739
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Burbank	2015 Chain	78	0	0	0	0.0001425	0.0002917	0.0004463	0.0006014
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Central	2015 Chain	78	0	0	0	0.0006444	0.0013213	0.0020319	0.0027689
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	North	2015 Chain	78	0	0	0	4.95464E-5	0.0001023	0.0001587	0.0002202
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	San Fernando	2015 Chain	78	0	0	0	0.0003421	0.0007006	0.0010766	0.0014658
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	San Gabriel Valley E	2015 Chain	78	0	0	0	0.0002197	0.0004495	0.0006898	0.0009306
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	San Gabriel Valley W	2015 Chain	78	0	0	0	0.0004174	0.0008536	0.0013048	0.0017565
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	South	2015 Chain	78	0	0	0	0.0002706	0.0005533	0.0008457	0.0011370
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	South Central	2015 Chain	78	0	0	0	0.0004548	0.0009309	0.0014286	0.0019378
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Southeast	2015 Chain	78	0	0	0	0.0005429	0.0011090	0.0016957	0.0022818
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	West	2015 Chain	78	0	0	0	0.0003719	0.0007613	0.0011707	0.0015939
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Orange Central	2015 Chain	78	0	0	0	0.0003085	0.0006310	0.0009677	0.0013066
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Orange North	2015 Chain	78	0	0	0	0.0001396	0.0002860	0.0004387	0.0005937
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Orange South	2015 Chain	78	0	0	0	0.0001708	0.0003527	0.0005453	0.0007461
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Orange West	2015 Chain	78	0	0	0	0.0002047	0.0004182	0.0006406	0.0008644
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Northwest Riversid	2015 Chain	78	0	0	0	0.0002590	0.0005331	0.0008208	0.0011087
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Riverside Other	2015 Chain	78	0	0	0	4.57252E-5	9.46087E-5	0.0001465	0.0002002
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Riverside Southwe:	2015 Chain	78	0	0	0	0.0001014	0.0002097	0.0003245	0.0004457
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	San Bernardino Cit	2015 Chain	78	0	0	0	0.0002157	0.0004425	0.0006799	0.0009181
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	Other San Bernard	2015 Chain	78	0	0	0	3.85649E-5	7.92465E-5	0.0001221	0.0001665
<input checked="" type="checkbox"/>	Consumption Reallocation (amount)	All Consumption Categories	San Bernardino So	2015 Chain	78	0	0	0	0.0002161	0.0004449	0.0006862	0.0009323

REMI: Public health benefits - mortality (1/2)

- Reduced mortality unclear what changes in consumer spending would occur. Modeled in REMI using non-pecuniary amenity aspects policy variable.
 - Increased attractiveness of region relative to rest of nation, induces economic migration, increases labor supply, lowers goods and services prices, raises housing prices, etc.

REMI: Public health benefits - mortality (2/2)

- Unclear how \$1 in social value from reduced mortality translates into amenity units/dollars.
- After deliberation with REMI staff and third-party consultant South Coast AQMD staff determined:
 - Need to provide range of regional economic outcomes based on lower- and upper-bound amenity values.
 - South Coast AQMD staff considered only mortality benefits from working-age population (age 25-65) (REMI recommends including all).
 - South Coast AQMD staff provided range of regional economic outcomes assuming \$1 in social value is worth \$0.50 in amenity value and then \$1 in amenity value.

REMI: Reduced mortality increases regional amenity value

Policy Variable Inputs

ive	Edit	Category	Notes
<input checked="" type="checkbox"/>		Composite (126 PV-s)	Reduced Consumer Spending on healthcare industries
<input checked="" type="checkbox"/>		Composite (21 PV-s)	Reallocation of reduced healthcare spending
<input checked="" type="checkbox"/>		Composite (21 PV-s)	Avoided Mortality Benefits (ages 25-65) at 100%

Items				PV Id									
Active	Category	Detail	Region	Unit Code	Variable Number	2014	2015	2016	2017	2018	2019	2020	2021
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Beach & Catalina	2015 Fixed	D41	0	0	0	26174707	54073884	83638575	112054253	140
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Burbank	2015 Fixed	D41	0	0	0	20441113	42331778	65668023	88030685	110
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Central	2015 Fixed	D41	0	0	0	86077703	178831781	277921589	374472248	471
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	North	2015 Fixed	D41	0	0	0	6903440	14444352	22641672	30607396	38
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	San Fernando	2015 Fixed	D41	0	0	0	46192721	95762913	148429770	198754064	250
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	San Gabriel Valley E	2015 Fixed	D41	0	0	0	31481048	65356633	101417384	136227903	171
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	San Gabriel Valley W	2015 Fixed	D41	0	0	0	55947613	115881383	179652642	240442921	301
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	South	2015 Fixed	D41	0	0	0	38421273	79577276	123322787	165074049	207
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	South Central	2015 Fixed	D41	0	0	0	56895595	118158275	183606325	245769387	309
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Southeast	2015 Fixed	D41	0	0	0	69536514	144198821	223380554	297947111	374
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	West	2015 Fixed	D41	0	0	0	51948451	107730904	167044532	223959313	281
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Orange Central	2015 Fixed	D41	0	0	0	33239270	68845542	106657239	142902719	179
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Orange North	2015 Fixed	D41	0	0	0	15863355	32910998	51041397	68533703	86
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Orange South	2015 Fixed	D41	0	0	0	20142162	42075914	65847951	88981461	111
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Orange West	2015 Fixed	D41	0	0	0	23274803	48176747	74570900	99908528	124
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Northwest Riverside	2015 Fixed	D41	0	0	0	34182430	71161213	110828398	150004389	188
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Riverside Other	2015 Fixed	D41	0	0	0	5301663	11140632	17533794	23899898	30
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Riverside Southwest	2015 Fixed	D41	0	0	0	12738998	26734310	41962475	56614477	72
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	San Bernardino Cit	2015 Fixed	D41	0	0	0	30508419	63304474	98351403	132048306	166
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	Other San Bernard	2015 Fixed	D41	0	0	0	6055097	12638600	19707928	26599425	33
<input checked="" type="checkbox"/>	Non-Pecuniary (Amenity) Aspects (amount)	Total	San Bernardino Sou	2015 Fixed	D41	0	0	0	34415431	71445141	111140174	149598561	188

REMI: Public health benefits - 2016 AQMP results and concerns

	Jobs			Average Annual (2017-2031)	
	2017	2023	2031	Jobs	% Change
Primary Scenario					
Quantified Public Health Benefits	1,294	21,017	43,481	23,036	0.20%
Mortality-Related Benefits	1,284	20,851	43,282	22,894	0.20%
Morbidity-Related Benefits	10	166	192	144	0.00%
Sensitivity Analysis					
Quantified Public Health Benefits (with Discounted Mortality-Related Benefits)	652	10,591	21,792	11,576	0.10%
Mortality-Related Benefits Discounted by 50%	642	10,425	21,582	11,431	0.10%

- Most positive job impacts stemmed from amenity enhancement due to public health benefits (mortality-related benefits).
- Still unclear to South Coast AQMD the most logically consistent manner to scale public health benefits into “amenity” value.

Questions/comments?

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