Chapter 4: Jobs and Other Macroeconomic Impacts

Preface

The projected macroeconomic impacts analyzed herein are preliminary and subject to future revision. Any potential revision is expected to relate to revisions to the incremental costs and public health benefits quantified and estimated in Chapters 2 and 3.

Chapters 2 and 3 of this report estimated the incremental costs and quantified the public health benefits associated with the proposed 2016 AQMP control measures, respectively. The control measures are designed to provide a path to clean air targets and address federal CAA requirements for ozone and PM2.5 standards. The costs and benefits of the 2016 AQMP are expected to alter, to various degrees, the economic decisions made by households, businesses, and other economic actors. Some businesses would see production costs go up while other businesses would benefit from a greater demand for their services and technologies. For consumers who consider purchasing or replacing vehicles or certain household appliances, the proposed control strategies would also change or widen the range of product choices that differ in fuel types, energy efficiency, effective unit prices, and therefore payback periods. In the meantime, improved public health would contribute to higher labor productivity and reduce healthcare-related expenditures. All these direct effects would then cascade through the regional economy and produce indirect and induced macroeconomic impacts. The immediate and subsequent effects may not just occur in the short-term, but some of them may also have lasting impacts that would subside only after a long period of time.

These direct, indirect, and induced macroeconomic impacts were assessed through a multi-year, multi-sector, and multi-region economic model customized by REMI for the SCAQMD.[1] This model contains 21 sub-county regions within the four-county area of Los Angeles, Orange, Riverside, and San Bernardino, and the rest of the world. The production of the model economy is comprised of 70 public and private sectors. The regionalized input-output framework used in the REMI model depicts the inter-industry relationships and interactions between different sectors of the model economy. The structure of each sub-county region's economy is represented through production, sales, and purchases between sectors; demand and supply of products in each sector; expenditures made by consumers, businesses, and governments; and trades of goods and services which occur between one sub-county region, the rest of the sub-county regions, and the rest of the world.

The macroeconomic impacts associated with the 2016 AQMP were simulated and projected relative to the baseline forecast for the regional economy, which excludes the implementation of the proposed control strategies in the 2016 AQMP. Consistent with the baseline air quality modeling and emission inventory analysis in the 2016 AQMP, the baseline economic forecast utilizes the 2016 SCAG Growth

[1] REMI Policy Insight Plus (PI+) South Coast Sub County Model v1.7.3 (Build 3967). For a full description of the REMI methodology, please refer to the REMI documentation available at http://www.remi.com/products/pi.

Forecast (SCAG 2016), specifically its population and employment projections.[2] The regional job impacts were simulated for incremental costs only, public health benefits only, and a combined scenario. The REMI model provides policy variables through which the incremental costs and public health benefits can be entered as changes to the economic variables or parameters in the model equations. In addition to job impacts, potential impacts on regional competitiveness are also reported in the sections below.

It should be emphasized that the REMI model is designed and used mainly to assess the potential macroeconomic impacts on the overall regional economy and the various sectors within the economy. It is not designed to predict potential impacts on an individual business or facility. Moreover, due to both model and data constraints, the analysis does not take into account the air quality management plans being proposed by other air districts, such as the 2016 ozone and PM2.5 plans by the San Joaquin Valley Air Pollution Control District. It is possible that the macroeconomic impacts of these other plans can potentially spillover to the South Coast region, therefore attenuating in some cases and reinforcing in other cases the macroeconomic impacts projected in this chapter. Further, the state and federal actions proposed by CARB would concurrently affect the four-county region and other regions in the state or in the nation, and these effects may change relative prices and other relative conditions between the regional economy and the rest of the world. However, these concurrent effects in other regions are not incorporated in the macroeconomic impact analysis because the customized REMI for the SCAQMD's socioeconomic assessment does not explicitly model regions outside the four counties. While these effects may also attenuate or reinforce the projected impacts, the magnitudes are expected to be sufficiently small.

Projected Job Impacts Due to Estimated Incremental Costs

As discussed in Chapter 2, the total present worth value (PWV) of incremental costs associated with the Revised Draft 2016 AQMP control strategies was estimated to be $15.5 billion, and the amortized annual average amounted to $1.4 billion per year between 2017 and 2031.[3] Consumers would see net cost savings of $2.3 billion, mainly due to fuel savings from zero and near-zero emissions light-duty vehicles and also from using residential appliances with higher energy efficiency. In the REMI model, these cost savings would then allow consumers to spend more on other goods and services, whether locally supplied or imported from outside the four-county area.[4]

Almost all private industry sectors in the regional economy are expected to incur varying amounts of cost increases as a direct result of implementing the proposed control strategies (see Table 2-2 in Chapter 2). The additional cost is modeled as a higher cost of doing business, along with a projected decrease in industry output which is seen as a direct effect of the increased costs. Even so, it should be noted that there are also cases where the proposed control strategies generate significant fuel or operation and maintenance cost-savings such that the cost of doing business may be partially offset or

[2] Appendix 4-A describes the 2016 SCAG projections of population and employment, as well as the procedures taken by staff to adjust and update the default REMI baseline forecasts based on SCAG projections and the modeling implications of this update.

[3] A revised Table 2-1 is provided with the release of Preliminary Draft Chapter 4. However, some of the cost revisions presented in this table are not yet reflected in the REMI simulations that produced the projected macroeconomic impacts reported in this chapter.

[4] See Appendix 4-B for the policy variables used in the REMI analysis associated with incremental costs.

actually decrease, especially when coupled with incentives. These decreases in costs would enable regional businesses to increase their output.

These direct changes in the cost of doing business are accompanied by an increased demand for air pollution control equipment or zero and near-zero emission technologies (e.g. low-NOx trucks, burners and heaters), as intended by the proposed control strategies in the 2016 AQMP. This would result in increased output and sales for the suppliers of this equipment which would additionally benefit the upstream suppliers who provide intermediate inputs to manufacture such equipment. These potential beneficial impacts flowing from the increased demand on suppliers would highly depend on the location(s) of the potential suppliers. Due to lack of such information in many cases, staff largely relied on REMI's embedded assumption regarding the share of increased local demand met by local *versus* outside suppliers.

The government sector is expected to incur the largest share of the total estimated incremental cost: about 93 percent, or $14.4 billion in PWV. The vast majority of this cost would be expended on the proposed incentive programs, which are devised to accelerate the deployment of zero and near-zero emission technologies. In the event where no additional revenues are raised, the estimated government spending to provide clean air incentives would need to be appropriated from unallocated and non-earmarked funds or from funds for discretionary programs that are supported by existing revenue sources. To be conservative about the prospect of securing additional public revenue from new sources and also to be consistent with CARB's modeling approach for the state's mobile source strategy (CARB 2016), the primary scenario of the REMI analysis assumed that all incentive programs would be funded by existing revenue sources for the state budget. This scenario would require a state government budget reallocation and affects the provision of public services in the REMI model. Moreover, this scenario conservatively assumes that the modeling approach adopted in this primary scenario considers that the budget reallocation only affects state funding for the four-county region and does not directly affect other regions within the state.

All of these different cost and demand changes are entered into the appropriate REMI policy variables. Overall, the incremental costs from implementation of the Revised Draft 2016 AQMP are projected to result in, on average, slightly more than 11,000 jobs foregone per year during the period from 2017 to 2031. The number of jobs foregone includes both potential job losses and forecasted jobs not created, and 11,000 jobs foregone would represent a 0.10 percent decrease from the baseline total of jobs in the four-county region. This represents an annualized job growth rate of 1.01 percent from 2016 to 2031, which implies a less than 0.01 percentage point slowdown from the baseline employment growth forecast. Table 4-1 shows the job impacts by industry sector for the initial implementation year of the 2016 AQMP (2017), the milestone years for ozone attainment demonstration (2023 and 2031), as well as the annual average between 2017 and 2031.

Table 4-1: Annual Regional Job Impacts of Incremental Costs by Sector
Assuming Incentive Programs Funded by Existing Sources of *State Government Revenues*
(Relative to Baseline)

Sector	NAICS	Jobs			Average Annual (2017-2031)	
		2017	2023	2031	Jobs	% Change
Agriculture, Forestry, Fishing, and Related Activities	11	-9	-8	1	-4	-0.03%
Mining, Oil and Gas Extraction	21	-58	-158	-299	-163	-0.62%
Utilities	22	-24	-103	-940	-249	-0.94%
Construction	23	-2,112	-2,443	-1,350	-1,643	-0.29%
Manufacturing	33	884	1,431	1,233	1,170	0.18%
Wholesale Trade	42	-260	-229	432	-25	-0.01%
Retail Trade	44-45	-1,167	-1,239	746	-672	-0.07%
Transportation and Warehousing	48-49	-296	-290	-83	-242	-0.06%
Information	51	-149	-110	24	-52	-0.02%
Finance and Insurance	52	-481	-336	146	-146	-0.03%
Real Estate and Rental and Leasing	53	-427	-520	-171	-329	-0.05%
Professional, Scientific, and Technical Services	54	-796	-875	-455	-581	-0.07%
Management of Companies and Enterprises	55	10	60	115	67	0.06%
Administrative and Waste Management Services	56	-974	-645	642	-136	-0.02%
Educational Services	61	-201	-209	-8	-116	-0.05%
Health Care and Social Assistance	62	-1,219	-1,292	-58	-719	-0.05%
Arts, Entertainment, and Recreation	71	-194	-137	63	-59	-0.02%
Accommodation and Food Services	72	-693	-1,029	-666	-761	-0.10%
Other Services, except Public Administration	81	-884	-744	401	-228	-0.03%
State and Local Government	92	-7,740	-9,387	-4,131	-6,395	-0.63%
Total		**-16,790**	**-18,263**	**-4,358**	**-11,284**	**-0.10%**

All sectors, except manufacturing (NAICS 33) and management of companies and enterprises (NAICS 55), are expected to have a lower level of employment relative to the baseline forecast. The jobs forgone projected for each of these sectors represent a decrease of less than one percent from each sector's baseline employment. The average annual job impacts show that the state and local governments together would account for more than half of overall jobs foregone in the region. Most of this projected decrease from the baseline forecast would occur to state employment within the four-county region, largely due to the modeling assumptions that the proposed incentive programs would be funded by existing sources of state government revenues and that this would only affect state budget spending within the four-county region.

In the REMI model, the reallocation of public funds to the proposed clean air incentive programs would directly result in funds diverted from local spending and thus jobs foregone in many sectors of the regional economy. For example, the construction sector would see jobs foregone mainly due to reduced government spending on local projects such as infrastructure improvements. Despite these projected decreases from the baseline level of forecast employment, the proposed incentive programs would create indirect benefits for the suppliers of zero and near-zero emission vehicles and equipment. However, the four-county region is not expected to reap much of these benefits since most of the equipment targeted by the proposed incentive programs was assumed to be manufactured outside the region, based on the current industry structure of the regional economy that is summarized in the simplified model economy. Whether this model assumption holds true throughout the analysis horizon will significantly impact both the direction and the magnitude of the REMI analysis results.

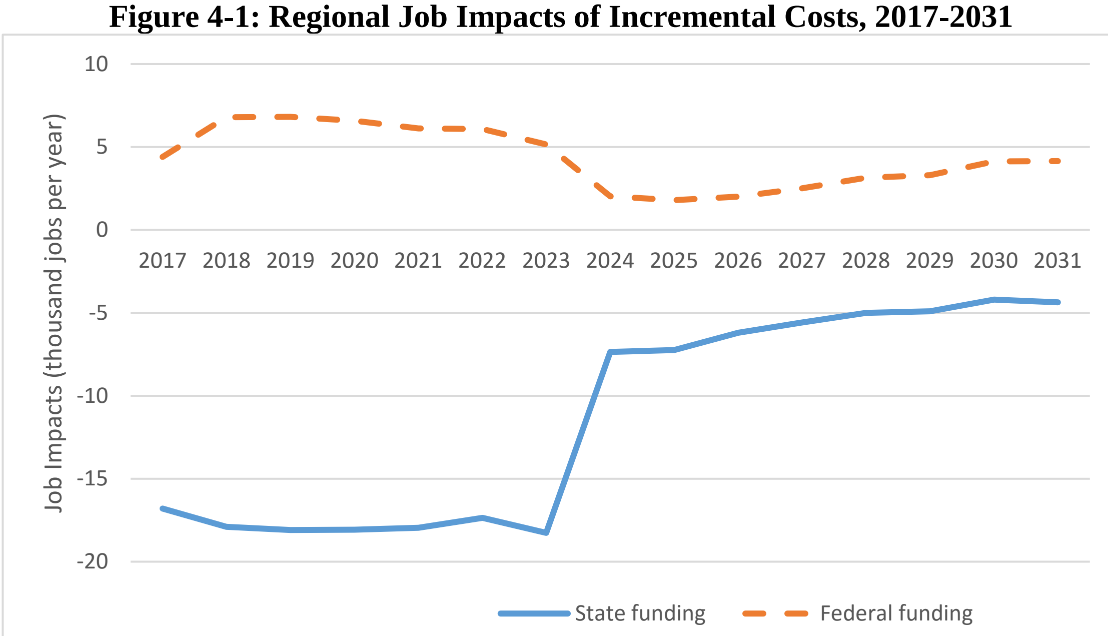
Another important assumption is the funding source of incentive programs. Table 4-2 presents the results of a sensitivity analysis where the funding for the proposed incentive programs comes from outside the four-county region and is considered as "free" money in the sense that it has minimal impacts on local public spending and the disposable income of the region's residents. This could arguably be the case when the proposed incentive programs are financed by existing federal funds. In this alternative scenario, implementation of the Revised Draft 2016 AQMP would result in an addition of average 4,300 jobs per year from 2017 to 2031, or a 0.04 percent increase from the overall baseline employment in the region. This job impact would barely change the forecast 1.02-percent annualized employment growth at the baseline.

These two scenarios analyze the job impacts from full funding from state only and federal only. In reality, the incentives will likely be funded from a combination of state and federal sources and hence the projected job impacts would likely fall in between these two scenarios (see Figure 4-1).

Table 4-2: Sensitivity Analysis of Annual Regional Job Impacts of Incremental Costs by Sector
Assuming Incentive Programs Funded by Existing Sources of *Federal Government Revenues*
(Relative to Baseline)

Sector	NAICS	Jobs			Average Annual (2017-2031)	
		2017	2023	2031	Jobs	% Change
Agriculture, Forestry, Fishing, and Related Activities	11	1	1	4	2	0.02%
Mining, Oil and Gas Extraction	21	-3	-114	-292	-135	-0.52%
Utilities	22	11	-63	-924	-222	-0.84%
Construction	23	287	138	-941	-38	-0.00%
Manufacturing	33	1,405	1,556	1,182	1,256	0.19%
Wholesale Trade	42	239	259	599	303	0.06%
Retail Trade	44-45	293	389	1,407	430	0.04%
Transportation and Warehousing	48-49	120	76	14	-6	0.00%
Information	51	45	51	63	50	0.02%
Finance and Insurance	52	213	237	308	231	0.04%
Real Estate and Rental and Leasing	53	112	131	123	116	0.02%
Professional, Scientific, and Technical Services	54	280	328	-42	216	0.03%
Management of Companies and Enterprises	55	100	117	120	103	0.09%
Administrative and Waste Management Services	56	313	789	1,152	808	0.09%
Educational Services	61	53	60	94	63	0.03%
Health Care and Social Assistance	62	303	381	679	422	0.03%
Arts, Entertainment, and Recreation	71	62	62	125	71	0.02%
Accommodation and Food Services	72	172	74	-161	-3	0.00%
Other Services, except Public Administration	81	264	307	777	481	0.07%
State and Local Government	92	136	369	-138	189	0.02%
Total		**4,405**	**5,149**	**4,147**	**4,334**	**0.04%**

Figure 4-1: Regional Job Impacts of Incremental Costs, 2017-2031



Projected Job Impacts of Quantified Public Health Benefits

Similar to the job impacts of incremental costs, the job impacts due to public health improvements were also simulated annually for the period of 2017 to 2031. Public health improvements consist of two components: avoided premature deaths and reduced morbidity incidence. These improvements were quantified and monetized as described in Chapter 3. The largest amount of public health benefits comes from the aggregated willingness-to-pay for a lower risk of premature deaths as a result of decreased exposure to PM2.5 and ozone, based on Value of Statistical Life (VSL). These monetized benefits, while not occurring in the market economy through direct transactions of goods and services, were considered to enhance the quality of life or amenity in the region. In the modeled economy, an increase in a region's amenity, which includes but is not limited to better environmental quality such as cleaner air, acts to attract more economic migrants into the region. Therefore, it directly increases local labor supply as well as local demand for housing, which in turn produces ripple effects throughout the regional economy.[5]

The other component of the public health benefits is derived from reduced morbidity incidence, such as fewer hospital admissions and visits to emergency departments, fewer absences from work and school, and fewer episodes of experiencing cardiovascular and respiratory symptoms. The monetized morbidity-related benefits are estimated based on the willingness-to-pay for a lower morbidity risk, and where those estimates are not available, the avoided cost of illness was used.[6] The portion of morbidity-related benefits associated with avoided work loss days and school loss days was valued based on the market price of a worker's productivity (i.e., hourly earnings) that results from less work absences due to fewer illnesses for adult workers and their children. These benefits were modeled in REMI as an increase in labor productivity for all industries in the region. Other morbidity-related benefits were considered to result in less spending on healthcare and related services, thus allowing households to reallocate their budget and increase spending on other goods and services. The change in healthcare-related expenditures was modeled as a decrease in consumer spending for six categories in the REMI model, including spending on hospitals, health insurance, nursing homes, paramedical services, pharmaceutical and other medical products, and physician services.

Table 4-3 shows the annual regional job impacts of quantified public health benefits for the initial implementation year of the 2016 AQMP (2017), the milestone years for ozone attainment demonstration (2023 and 2031), as well as the annual average between 2017 and 2031. Under the primary scenario, the public health benefits are projected to increase the number of jobs in the region by about 21,000 in 2023 and 43,500 in 2031 relative to the baseline. The annual job impacts for the analysis horizon of 2017-2031 correspond with an average annual increase of 23,000 jobs, which is about 0.2 percent above the baseline regional total jobs. The mortality-related benefits contribute the largest share to the number of jobs gained, at about 22,900 on average per year, while morbidity-related benefits (increased labor productivity and reduced healthcare costs) contribute fewer than 200 jobs per year on average.

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[5] The amount of mortality-related public health benefits entered is then converted into a change in the non-monetary, quality-of-life component of the migration equation in the model. As this mechanism works through the channel of economic migration, only the portion of quantified mortality-related benefits accrued to the working age population (age group 25 to 64), or about 17% of the total mortality-related benefits, were entered into the REMI model. See Appendix 4-B for more discussion and also for the policy variables used in the REMI analysis associated with public health benefits.

[6] This specific methodology was recommended by IEc (Industrial Economics and Robinson 2016).

Table 4-3: Annual Regional Job Impacts of Quantified Public Health Benefits
(Relative to Baseline)

	Jobs			Average Annual (2017-2031)	
Primary Scenario	**2017**	**2023**	**2031**	**Jobs**	**% Change**
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%

Note: REMI model results are not additive, so the total job impact can not necessarily be found from adding the individual components.

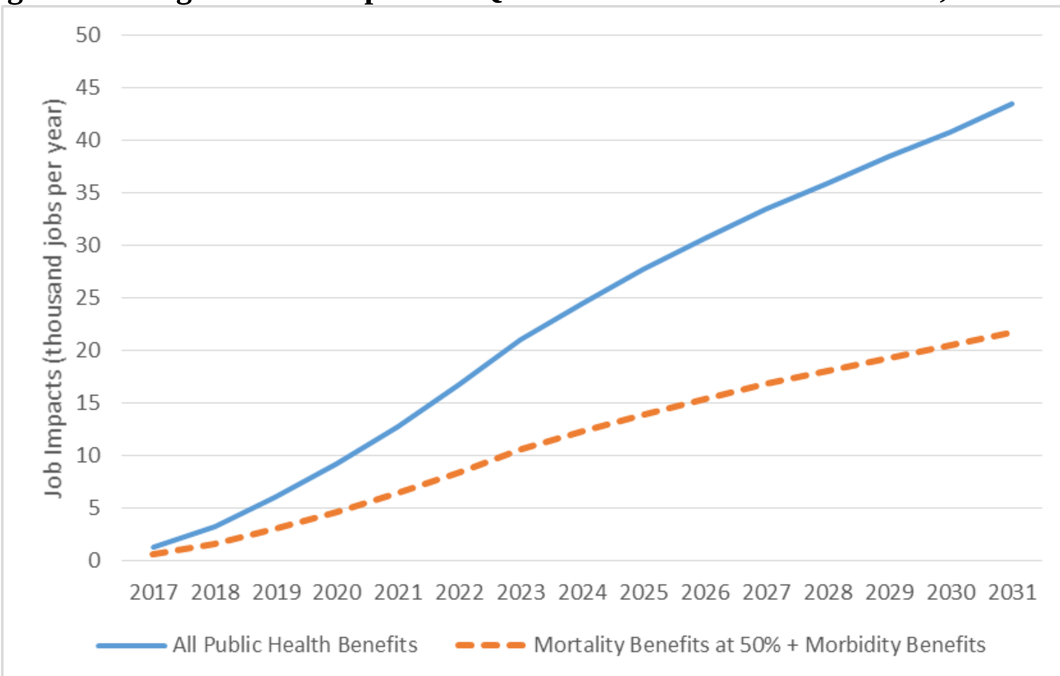
The mortality-related public health benefits were derived from the willingness-to-pay to lower mortality risk with certainty, which is a non-market good. Due to remaining uncertainties surrounding the macroeconomic modeling of non-market benefits and whether the amount of the benefits should be adjusted before being entered into REMI to enact regional amenity improvements (Abt Associates 2014; Lahr 2016), a sensitivity analysis was performed where the monetized benefits associated with avoided premature deaths were discounted by half as REMI amenity inputs. The sensitivity test was performed based on recommendations in the 2014 Abt Report and a separate third-party evaluation (Lahr, 2016).[7] The purpose was to examine how sensitive job impacts are to the inputs of REMI policy variable "Non-pecuniary (Amenity) Aspects".

In order to have comparable results, the sensitivity analysis scenario was conducted for both components of public health benefits combined and for the mortality-related portion separately. The results of the sensitivity analysis reported in Table 4-3, show that the job impacts of the total quantified public health benefits are reduced by half when the value of amenity inputs is reduced by the same magnitude. This approximately one-to-one correlation (correspondence of reduction in job impacts) is due to the fact that mortality benefits account for over 99 percent of total quantified public health benefits. Overall, the sensitivity test results suggest that, if any scaling or weighting is necessary for the non-market clean air benefits to enter into REMI as regional amenity improvement, the job impacts as projected by REMI would be reduced by approximately the same factor.

[7] The 2014 Abt report recommended that the SCAQMD "initiate a research task to consider the weighting of estimates of air quality benefits to reflect the relative importance of air quality changes compared to other area specific amenities" and "keep abreast of the USEPA's development of methods for applying benefits in economy-wide models." The sensitivity test is staff's initial effort to implement the former recommendation, and the latter recommendation was also being implemented concurrently. The Abt report further recommended an evaluation of REMI's logic for incorporating amenities in its model; however, REMI contested the reasoning behind this recommendation.

Figure 4-2 shows how the job impacts change over the course of the analysis horizon. Under both the primary scenario and sensitivity test, the job impacts grow at a relatively faster rate between 2017 and 2023 and relatively slower rate from 2024 to 2031, mirroring the year-to-year change of quantified public health benefits.

Figure 4-2: Regional Job Impacts of Quantified Public Health Benefits, 2017-2031



As discussed above, the regional job impacts of quantified public health benefits are driven by three forces at work. First, increased economic migration into the region, due to improved regional amenities (or "quality of life"), would result in a larger labor supply and also higher demand for goods and services, thus creating ripple effects throughout the regional economy. Second, the benefits related to avoided morbidity incidence would decrease healthcare-related consumer spending, thus directly resulting in reduced jobs and output in healthcare industries; these healthcare savings can then be spent on other goods and services, which would result in positive job impacts when these goods and services are supplied by local businesses and industries. Third, increased labor productivity due to fewer absences from work would make the region more competitive, thus driving up output and employment in all sectors. Table 4-4 shows the distribution of job impacts across all major sectors under the primary scenario. All sectors are projected to experience job gains relative to the baseline. The largest job gain, in both absolute and percentage terms, is expected in the state and local government sector. This is mainly due to increases in public services and infrastructure investments in the region to accommodate a larger population because of increased migration into the area. For the same reason, the construction sector and the accommodation and food services sector are also projected to see large gains in jobs. Some of the least impacted sectors are the agriculture, forestry, fishing, and related activities sector; the mining sector; and the information sector.

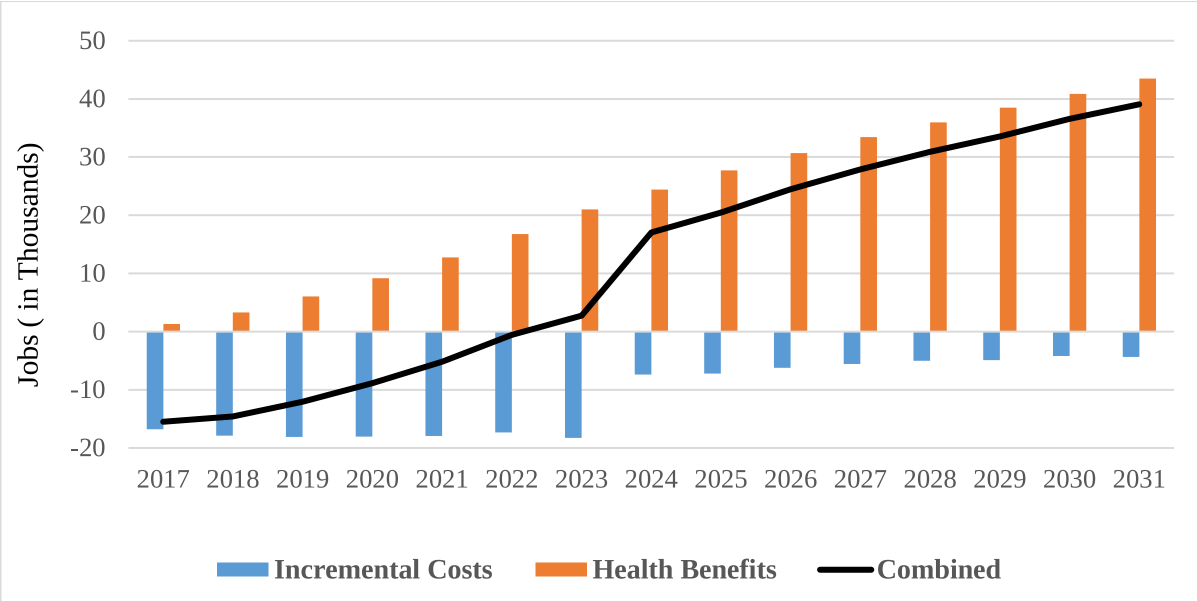
Table 4-4: Annual Regional Job Impacts of Quantified Public Health Benefits by Sector
(Relative to Baseline)

		Jobs			Average Annual (2017-2031)	
Sector	**NAICS**	**2017**	**2023**	**2031**	**Jobs**	**% Change**
Agriculture, Forestry, Fishing, and Related Activities	11	0	6	13	7	0.05%
Mining, Oil and Gas Extraction	21	3	19	20	15	0.06%
Utilities	22	4	66	138	73	0.28%
Construction	23	152	2,188	3,179	2,049	0.34%
Manufacturing	33	46	679	1,375	740	0.11%
Wholesale Trade	42	37	572	1,274	652	0.13%
Retail Trade	44-45	139	2,136	4,570	2,384	0.22%
Transportation and Warehousing	48-49	23	318	756	371	0.10%
Information	51	12	160	405	192	0.06%
Finance and Insurance	52	33	320	887	401	0.07%
Real Estate and Rental and Leasing	53	85	1,436	3,268	1,655	0.24%
Professional, Scientific, and Technical Services	54	63	1,033	2,075	1,117	0.12%
Management of Companies and Enterprises	55	8	120	262	135	0.11%
Administrative and Waste Management Services	56	72	1,202	2,561	1,335	0.15%
Educational Services	61	33	538	1,098	583	0.23%
Health Care and Social Assistance	62	127	2,444	6,129	2,941	0.21%
Arts, Entertainment, and Recreation	71	14	155	500	210	0.06%
Accommodation and Food Services	72	143	2,627	5,396	2,888	0.38%
Other Services, except Public Administration	81	63	660	1,740	805	0.11%
State and Local Government	92	238	4,337	7,833	4,486	0.42%
Total		**1,294**	**21,017**	**43,481**	**23,036**	**0.20%**

Projected Job Impacts of the Revised Draft 2016 AQMP

The simulation of the regional economy with all of the incremental cost and benefit-related policy variables combined together represents the regional economic impact of the Revised Draft 2016 AQMP. Figure 4-2 illustrates how the net job impacts of the Draft 2016 AQMP change over time, along with the job impacts attributable separately to incremental costs and public health benefits under their respective primary scenarios as described in the previous sections (i.e., incentives funded by existing state revenue sources and full air-related public health benefits for regional amenity adjustments). Overall, the regional economy is projected to experience jobs forgone in the first years because the negative effects, mainly associated with the incremental costs of proposed control measures, would dominate the positive effect that largely stems from public health benefits. Over time, however, as public health benefits continue to increase, net job gains are projected for most of the industries.

Figure 4-2: Regional Job Impacts of the Revised Draft 2016 AQMP, 2017-2031



On an annual average, the combined effects of public health benefits and incremental costs associated with the Revised Draft 2016 AQMP are expected to result in a gain of 12,000 jobs per year from 2017 to 2031, relative to the baseline employment forecast. This represents an annualized job growth rate of 1.04 percent, or a 0.02 percentage point acceleration from the baseline employment growth during the same period. Table 4-5 reports the average annual net job impacts by sector. It is projected that the initial negative job impacts would spread among most of the public and private sectors. However, almost half of the 15,500 jobs foregone projected for year 2017 are concentrated in the state and local government sector. Construction, retail trade, and healthcare and social assistance sectors would also have more than 1,000 jobs foregone in that year. However, by 2023, most sectors would see increases in employment from their baseline forecast. In 2031, only mining and utilities sectors would still experience jobs foregone; however, on an annual average, the net negative job impact for these two sectors are expected to be less than one percent lower than their baseline employment level. All of these changes are relatively small when compared with the overall size of the four-county economy.

Under the alternative scenario where incentives are financed by existing federal funds, the projected combined job impact becomes an average gain of 27,000 jobs per year, relative to the baseline employment forecast. The corresponding annualized job growth rate will increase very slightly and remain at around 1.04 percent from 2017 to 2031.

Table 4-5: Annual Net Job Impacts by Sector
(Relative to Baseline)

Sector	NAICS	Jobs 2017	Jobs 2023	Jobs 2031	Average Annual (2017-2031) Jobs	Average Annual (2017-2031) % Change
Agriculture, Forestry, Fishing, and Related Activities	11	-8	-2	14	2	0.02%
Mining, Oil and Gas Extraction	21	-55	-139	-279	-148	-0.57%
Utilities	22	-20	-38	-803	-177	-0.67%
Construction	23	-1,960	-255	1,828	404	0.05%
Manufacturing	33	931	2,110	2,607	1,910	0.29%
Wholesale Trade	42	-223	343	1,705	626	0.12%
Retail Trade	44-45	-1,028	898	5,310	1,709	0.16%
Transportation and Warehousing	48-49	-273	28	674	129	0.03%
Information	51	-137	50	428	141	0.04%
Finance and Insurance	52	-448	-15	1,031	254	0.04%
Real Estate and Rental and Leasing	53	-342	915	3,092	1,324	0.19%
Professional, Scientific, and Technical Services	54	-733	158	1,617	534	0.06%
Management of Companies and Enterprises	55	17	179	377	202	0.17%
Administrative and Waste Management Services	56	-902	558	3,201	1,197	0.13%
Educational Services	61	-169	329	1,090	466	0.18%
Health Care and Social Assistance	62	-1,092	1,152	6,064	2,221	0.15%
Arts, Entertainment, and Recreation	71	-180	19	562	150	0.04%
Accommodation and Food Services	72	-550	1,596	4,722	2,123	0.28%
Other Services, except Public Administration	81	-821	-83	2,139	577	0.08%
State and Local Government	92	-7,502	-5,054	3,695	-1,913	-0.21%
Total		**-15,494**	**2,749**	**39,074**	**11,731**	**0.10%**

Table 4-6 shows the distribution of net job impacts in 2017, 2023, and 2031 among five groups categorized by occupational earnings. In general, the job impacts are distributed rather evenly across all five groups, with no positive or negative job impacts overwhelmingly borne by any particular group. All groups are projected to see small numbers of jobs foregone in 2017 which mirrors the initial negative job impacts among various sectors. In 2031, all groups are projected to experience small job gains of 0.3 to 0.4 percent, relative to the baseline forecast.

Table 4-6: Net Job Impacts by Occupational Earnings Group

Group	2015 Median Weekly Earnings*	% Impact from Baseline			No. of Occupations
		2017	2023	2031	
1	$236 - $480	-0.12%	0.08%	0.41%	19
2	$481 - $619	-0.12%	0.05%	0.34%	19
3	$620 - $767	-0.15%	0.03%	0.32%	19
4	$768 - $980	-0.26%	-0.08%	0.31%	19
5	$990 - $1738	-0.14%	0.01%	0.26%	19

*Source: REMI. For the list of occupations by earning group, see Appendix 4-B

Projected Net Competitiveness Impacts

Regional economic competitiveness depends on various interrelated factors. A primary factor is the cost of operating a business in a region, which varies from industry to industry. Some industries may rely heavily on local market demand while others export goods and services to other regions. Businesses in some industry sectors tend to physically cluster with their competitors, as well as upstream and downstream firms, to foster network effects and create economies of agglomeration. In contrast, in other industries, businesses need not locate in close proximity to competitors or upstream/downstream firms to be competitive. Besides the industry-specific factors, the health and productivity of the region's workforce is another important determinant, and both cost of living and quality of life play a role in the size and makeup of a region's labor pool. Additionally, regional economic competitiveness can be also affected by policy decisions and public investment, such as the adequacy and conditions of regional infrastructure, as well as the regulatory environment and enforcement. As discussed in previous sections, the 2016 AQMP will potentially affect regional economic competitiveness through three major channels: (1) by increasing costs or introducing cost-savings for regional businesses, consumers, and the public sector as a result of the proposed control strategies; (2) by reducing air pollution-related health risks for the workforce and their dependents; and 3) by enhancing quality of life for the region's residents via public health and other clear air-related welfare benefits.

Having analyzed the benefits of clean air to the region's population and workforce, this section discusses net competitiveness impacts from the perspective of business operations. The REMI model, used to estimate potential job impacts of the 2016 AQMP, also projects impacts on value-added, cost of production, prices of locally manufactured goods, as well as exports and imports.

Impacts on Value-Added

Value-added is the gross output of an industry less the value of its intermediate inputs, also referred to as the gross domestic product (GDP)-by-industry. Table 4-8 shows the percent change of value-added from the baseline. The impacts associated with incremental costs only are mostly negative, and the impacts associated with public health benefits only are mostly positive. The overall impacts of the Revised Draft 2016 AQMP on value-added are largely negative in the beginning years of plan implementation, but then become positive towards the later years. However, the magnitude of these impacts are negligible, with a combined cost/benefit impact of less than one percent for the majority of industries.

Table 4-8: Impacts on Value-Added by Industry
(Relative to Baseline**)**

Industry	Incremental Costs			Health Benefits			Combined Costs and Benefits		
	2017	2023	2031	2017	2023	2031	2017	2023	2031
Forestry, Fishing, Other	-0.07%	-0.05%	0.09%	0.01%	0.07%	0.11%	-0.07%	0.01%	0.20%
Mining, Oil and Gas Extraction	-0.25%	-0.67%	-1.29%	0.01%	0.06%	-0.08%	-0.24%	-0.61%	-1.37%
Utilities	-0.10%	-0.40%	-3.45%	0.02%	0.24%	0.41%	-0.08%	-0.16%	-3.04%
Construction	-0.42%	-0.42%	-0.21%	0.03%	0.36%	0.45%	-0.39%	-0.06%	0.23%
Manufacturing	0.12%	0.20%	0.13%	0.01%	0.08%	0.14%	0.13%	0.28%	0.26%
Wholesale Trade	-0.06%	-0.05%	0.08%	0.01%	0.11%	0.20%	-0.05%	0.06%	0.28%
Retail Trade	-0.12%	-0.12%	0.07%	0.02%	0.20%	0.37%	-0.11%	0.08%	0.44%
Transportation and Warehousing	-0.08%	-0.13%	-0.24%	0.01%	0.07%	0.14%	-0.07%	-0.06%	-0.10%
Information	-0.08%	-0.07%	-0.01%	0.01%	0.07%	0.13%	-0.07%	0.00%	0.12%
Finance and Insurance	-0.10%	-0.08%	0.01%	0.01%	0.06%	0.12%	-0.09%	-0.02%	0.13%
Real Estate, Rental, and Leasing	-0.07%	-0.07%	-0.02%	0.01%	0.18%	0.31%	-0.05%	0.11%	0.29%
Professional and Technical Services	-0.10%	-0.10%	-0.05%	0.01%	0.11%	0.19%	-0.09%	0.02%	0.14%
Management of Companies and Entr.	0.01%	0.05%	0.09%	0.01%	0.10%	0.19%	0.02%	0.15%	0.28%
Administrative and Waste Services	-0.13%	-0.04%	0.10%	0.01%	0.14%	0.26%	-0.12%	0.10%	0.35%
Educational Services	-0.09%	-0.09%	-0.01%	0.02%	0.22%	0.39%	-0.07%	0.13%	0.39%
Health Care and Social Assistance	-0.11%	-0.10%	-0.01%	0.01%	0.18%	0.39%	-0.10%	0.07%	0.38%
Arts, Entertainment and Recreation	-0.06%	-0.04%	0.02%	0.01%	0.04%	0.07%	-0.05%	0.00%	0.09%
Accommodation and Food Services	-0.10%	-0.13%	-0.07%	0.02%	0.33%	0.61%	-0.08%	0.19%	0.53%
Other Services (ex. Government)	-0.14%	-0.12%	0.07%	0.01%	0.09%	0.19%	-0.13%	-0.03%	0.26%

Impacts on Cost of Production

Table 4-9 shows the percent change in cost of production relative to the rest of the United States, as a result of implementing the Revised Draft 2016 AQMP. The impacts associated with incremental costs are mostly negative in 2017 and 2023 when most of government incentives are assumed to occur assisting consumers and industry in reducing the financial burden of acquiring equipment made with zero and near-zero emission technologies. In some cases, especially when large cost-savings from operation and maintenance are anticipated, the assumed incentive amounts could be significant enough to largely offset the incremental cost of capital equipment, thus resulting in an immediate lowering of production costs. Moreover, due to the modeling assumption that no additional revenues would be raised to fund the proposed incentives, the incentive payouts from government would necessitate a decrease in public spending in other function areas. These spending decreases would reduce local demand for goods and services across many industry sectors, thereby also reducing their demand for capital, labor, and other inputs. With lower demands for these inputs, their price would drop and therefore reduce the cost of production. While these incentives are being spent by consumers and industry elsewhere in the economy, much of it is on equipment manufactured outside the region, thus much of the impact occurs outside the region.

The impacts associated with public health benefits mainly increase production costs. By attracting more economic migrants into the region via improved quality of life, the population increase would increase demand for housing and drive up land costs as well. This will eventually translate into higher capital costs, and therefore increasing production costs. It should be noted that increased economic migration would also increase labor supply and lower wage rates. However, in the REMI model built for the four-county region, the improved amenity, or quality of life, exerts more upward pressure on capital costs than downward impacts on wages, thus increasing the overall costs of production.

Overall, the utility sector is projected to experience the highest increase (0.27 percent in 2023 and 0.62 percent in 2031) as a result of the Revised Draft 2016 AQMP, due to the many proposed stationary and mobile source control measures affecting cost and output of the sector including: Advanced Clean Cars 2, Advanced Clean Transit, CMB-01, CMB-05, and ECC-03 (for more details see Appendix 4-B). All the remaining sectors will experience a smaller magnitude of production cost impacts, whether positive or negative, on their costs of production. All of these changes are relatively small when compared with the overall size of the four-county economy

Table 4-9: Impacts on Cost of Production by industry
(Relative to Baseline)

Industry	Incremental Costs			Health Benefits			Combined Costs and Benefits		
	2017	2023	2031	2017	2023	2031	2017	2023	2031
Forestry, Fishing, Other	-0.01%	-0.03%	0.00%	0.00%	0.00%	-0.02%	-0.01%	-0.03%	-0.02%
Mining, Oil and Gas Extraction	0.01%	-0.03%	0.06%	0.00%	0.19%	0.38%	0.01%	0.17%	0.44%
Utilities	-0.01%	0.16%	0.39%	0.00%	0.11%	0.23%	-0.01%	0.27%	0.62%
Construction	-0.01%	-0.03%	0.01%	0.00%	0.01%	0.00%	-0.01%	-0.02%	0.01%
Manufacturing	-0.01%	-0.01%	0.02%	0.00%	0.01%	0.01%	-0.01%	0.00%	0.02%
Wholesale Trade	-0.01%	-0.03%	-0.01%	0.00%	0.01%	0.02%	-0.01%	-0.02%	0.00%
Retail Trade	-0.01%	-0.04%	-0.01%	0.00%	0.03%	0.05%	-0.01%	-0.01%	0.04%
Transportation and Warehousing	0.01%	0.19%	0.35%	0.00%	0.01%	0.00%	0.01%	0.19%	0.35%
Information	-0.01%	-0.04%	-0.02%	0.00%	0.03%	0.06%	-0.01%	0.00%	0.04%
Finance and Insurance	-0.01%	-0.05%	-0.02%	0.00%	0.04%	0.07%	-0.01%	-0.01%	0.05%
Real Estate, Rental, Leasing	-0.01%	-0.06%	-0.03%	0.00%	0.15%	0.29%	-0.01%	0.09%	0.27%
Professional and Technical Services	-0.01%	-0.04%	-0.02%	0.00%	0.00%	-0.01%	-0.01%	-0.04%	-0.03%
Management of Companies and Entr.	-0.01%	-0.04%	-0.01%	0.00%	-0.01%	-0.03%	-0.01%	-0.05%	-0.04%
Administrative and Waste Services	-0.07%	-0.34%	-0.55%	0.00%	0.00%	-0.01%	-0.07%	-0.34%	-0.56%
Educational Services	-0.02%	-0.07%	-0.03%	0.00%	0.01%	0.00%	-0.02%	-0.07%	-0.03%
Health Care and Social Assistance	-0.01%	-0.05%	-0.03%	0.00%	0.00%	-0.01%	-0.02%	-0.05%	-0.03%
Arts, Entertainment and Recreation	-0.01%	-0.05%	-0.02%	0.00%	0.05%	0.09%	-0.01%	0.00%	0.06%
Accommodation and Food Services	-0.01%	-0.01%	0.07%	0.00%	0.03%	0.06%	-0.01%	0.03%	0.13%
Other Services (ex. Government)	-0.01%	-0.05%	-0.02%	0.00%	0.03%	0.04%	-0.01%	-0.02%	0.03%

Impacts on Delivered Prices

Changes in production costs will affect prices of goods produced locally. The relative delivered price of a good is based on its production cost and the transportation cost of delivering the good to where it is consumed or used. Thus, the impact of implementing the Revised Draft 2016 AQMP on the delivered price mimics the cost of production. A lower cost of production translates to lower delivered prices, and *vice versa*.

Table 4-10: Impacts on Delivered Prices by Industry

(Relative to Baseline)

Industry	Incremental Costs			Health Benefits			Combined Costs and Benefits		
	2017	**2023**	**2031**	**2017**	**2023**	**2031**	**2017**	**2023**	**2031**
Forestry, Fishing, Other	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Mining, Oil and Gas Extraction	0.00%	-0.01%	0.02%	0.00%	0.09%	0.18%	0.00%	0.08%	0.21%
Utilities	0.00%	0.13%	0.32%	0.00%	0.09%	0.19%	-0.01%	0.22%	0.51%
Construction	-0.01%	-0.02%	0.01%	0.00%	0.01%	0.00%	-0.01%	-0.01%	0.01%
Manufacturing	0.00%	-0.01%	0.01%	0.00%	0.01%	0.00%	0.00%	0.00%	0.01%
Wholesale Trade	-0.01%	-0.03%	-0.01%	0.00%	0.01%	0.02%	-0.01%	-0.02%	0.00%
Retail Trade	-0.01%	-0.03%	-0.01%	0.00%	0.03%	0.05%	-0.01%	-0.01%	0.04%
Transportation and Warehousing	0.01%	0.10%	0.14%	0.00%	0.01%	0.00%	0.01%	0.10%	0.15%
Information	-0.01%	-0.03%	-0.02%	0.00%	0.03%	0.06%	-0.01%	0.00%	0.04%
Finance and Insurance	-0.01%	-0.03%	-0.01%	0.00%	0.03%	0.04%	-0.01%	0.00%	0.03%
Real Estate, Rental, and Leasing	-0.01%	-0.06%	-0.02%	0.00%	0.15%	0.29%	-0.01%	0.09%	0.27%
Professional and Technical Services	-0.01%	-0.04%	-0.02%	0.00%	0.00%	-0.01%	-0.01%	-0.04%	-0.03%
Management of Companies and Entr.	-0.01%	-0.03%	-0.01%	0.00%	-0.01%	-0.03%	-0.01%	-0.04%	-0.04%
Administrative and Waste Services	-0.06%	-0.31%	-0.50%	0.00%	0.00%	-0.01%	-0.06%	-0.31%	-0.51%
Educational Services	-0.01%	-0.05%	-0.02%	0.00%	0.00%	0.00%	-0.01%	-0.04%	-0.02%
Health Care and Social Assistance	-0.01%	-0.04%	-0.02%	0.00%	0.00%	0.00%	-0.01%	-0.03%	-0.02%
Arts, Entertainment and Recreation	-0.01%	-0.04%	-0.02%	0.00%	0.04%	0.06%	-0.01%	0.00%	0.04%
Accommodation and Food Services	-0.01%	0.00%	0.06%	0.00%	0.03%	0.05%	-0.01%	0.02%	0.11%
Other Services (ex. Government)	-0.01%	-0.04%	-0.02%	0.00%	0.03%	0.04%	-0.01%	-0.02%	0.02%

Impacts on Imports and Exports

Table 4-11 summarizes the combined impact of the incremental cost of control measures and the public health benefits on the region's exports and imports relative to the baseline projections. Changes in exports reflect the changes in relative cost of production and delivered prices, thus its impact would mimic the impacts discussed above. On the other hand, as a result of population increase in the region, imports are expected to increase. As shown in the table below, all of these changes are relatively small when compared with the overall size of the four-county economy.

Table 4-11: Impacts on Imports and Exports
($Millions/Percent Change Relative to Baseline)

Category	2017		2023		2031	
Exports	$28	0.01%	$63	0.01%	-$25	0.00%
Imports	$2,189	0.33%	$1,963	0.31%	$4,410	0.51%

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Chapter 5: Sub-Regional Distribution of Incremental Costs, Public Health Benefits, and Jobs Impacts

Preface

The projected macroeconomic impacts analyzed herein are preliminary and subject to future revision. Any potential revision is expected to relate to revisions to the incremental costs and public health benefits quantified and estimated in Chapters 2 and 3.

This chapter assesses the sub-regional distribution of incremental costs, public health benefits, and job impacts to provide information on how the Draft 2016 AQMP may affect different communities within the four-county region of Los Angeles, Orange County, Riverside and San Bernardino. AsFigure 5-1 shows, there are 11 sub-county regions within Los Angeles County, four within Orange County, and three each within Riverside and San Bernardino counties. The four counties are divided into these sub-county regions based on socioeconomic characteristics found in the U.S. Census Bureau's American Community Survey (Lieu, Dabirian, and Hunter 2012). The REMI model used to simulate regional macroeconomic impacts based on the incremental costs and public health benefits of the Revised Draft 2016 AQMP was customized according to these same sub-county definitions.

Figure 5-1: 21 Sub-County Regions

Description of the 21 Sub-County Regions in the REMI Model

With six commercial airports, the nation's two largest marine ports, and over 8 million workers[1] generating more than a trillion dollars in GDP[2], the regional economy of Los Angeles, Orange, Riverside, and San Bernardino counties is one of the largest and most productive in the United States. This section provides a snapshot of how different communities within the four-county region vary according to key demographic and economic indicators. All indicators discussed below are based on the REMI baseline projections that have been adjusted according to the 2016 SCAG Growth Forecast (see Appendix 4-A).

The four-county region is home to nearly 18 million people. By 2031, the region is expected to gain an additional two million people (SCAG 2016). About 75 percent of the region's population, or about 14 million people, reside in the coastal counties of Los Angeles and Orange, while the remaining 25 percent, or about 4 million people, live further inland in Riverside and San Bernardino counties. Figure 5-2 (a) demonstrates the population distribution among 21 sub-county regions in 2016, while Figure 5-2 (b) shows widely varying population density in each of the sub-regions.

The densest populated areas in the region are the South Central and Central sub-regions in Los Angeles County. South Central is home to a little over a million people, or roughly 15,000 people per square mile. The Central sub-region in Los Angeles also has a population over a million and a density of 13,000 people per square mile. The densest populated areas in Orange County are the Central and Western sub-regions, which have a population density of 10,000 and 6,000 people per square mile respectively. In comparison, the sub-regions further inland are much less densely populated. San Bernardino City, San Bernardino Southwest, and Northwest Riverside, for example, have population densities of 3,000 people per square mile, about one fifth of the population density in South Central Los Angeles.

[1] EDD estimates as of July 2016.
[2] U.S. Bureau of Economic Analysis, 2015 GDP estimates for Los Angeles-Long Beach-Anaheim and Riverside-San Bernardino-Ontario metros.

Figure 5-2 (a): Population by Sub-County Region, 2016

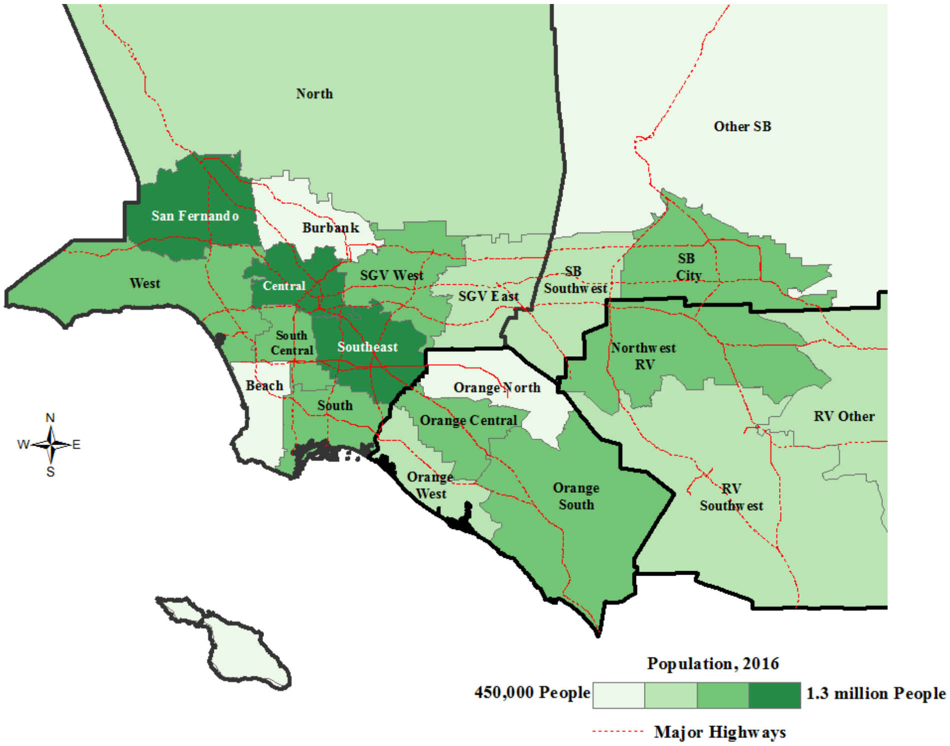
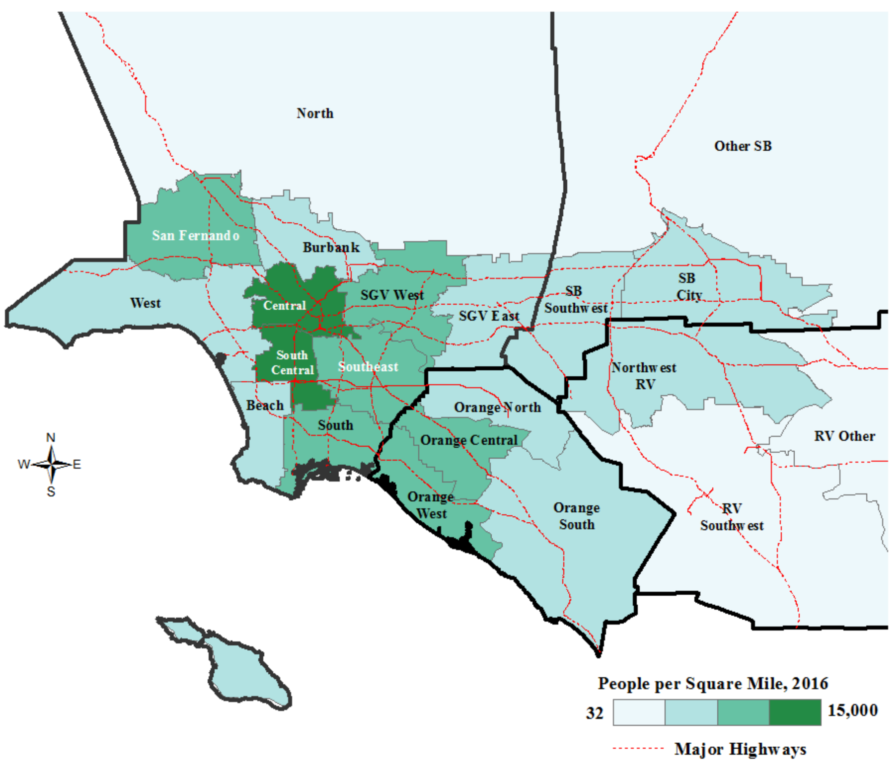


Figure 5-2 (b): Population Density by Sub-County Region, 2016



Regarding employment, as seen in Figure 5-3, jobs are largely concentrated in the Central and Western sub-regions of Los Angeles, which collectively provide nearly one out of every five jobs in the region. In the Inland area, the largest concentration of jobs is found along the San Bernardino and Riverside border, yet this cluster of San Bernardino Southwest, San Bernardino City, and Northwest Riverside only supplies about one out of every ten jobs in the region.

Figure 5-3: Total Employment by Sub-County Region, 2016

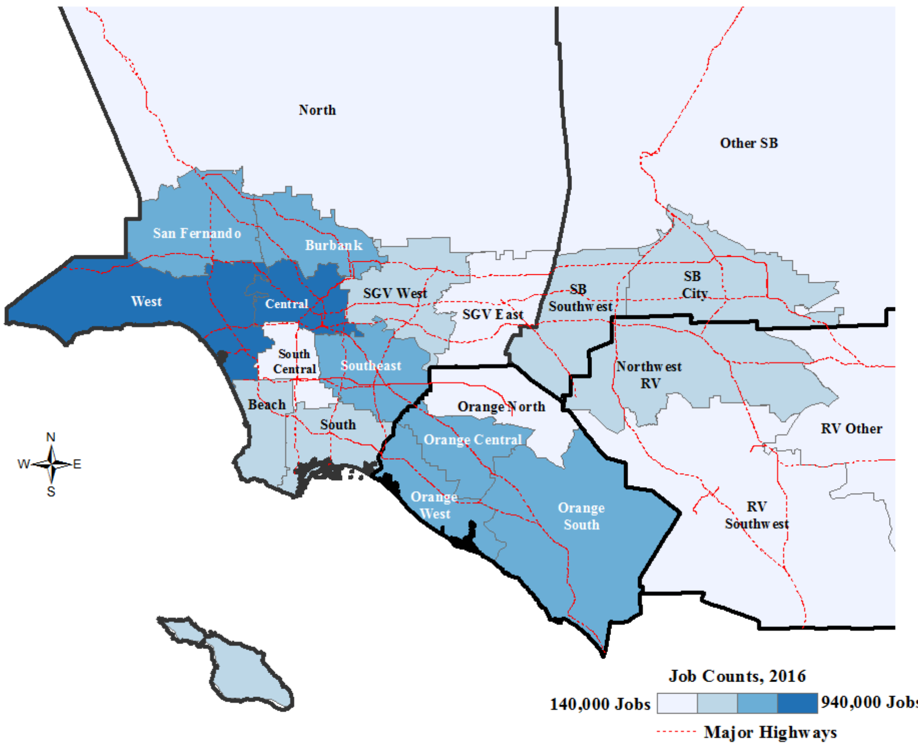


Figure 5-4 (a) shows the number of jobs per working age adult (25 to 64 years old). Most sub-county regions have about one job per working-age adult, with a few exceptions. The South Central and Other San Bernardino regions have relatively scarce employment opportunities, with less than one job per working-age adult. In comparison, residents in Burbank and the West region of Los Angeles have better employment prospects, with approximately two jobs per working-age adult. Figure 5-4 (b) illustrates the age-dependency ratio, defined as the number of those too young or elderly to work per working-age adult. The western region of Los Angeles has the lowest age-dependency ratio of 43 dependents per 100 workers; whereas, eastern Riverside has the largest at 58 dependents per 100 workers. Higher age-dependency ratios in the inland area than in Los Angeles or Orange counties is largely a result of proportionally more families with young children and more affordable family housing, but it also indicates more pressure on workers in these areas, as well as in certain areas in Los Angeles and Orange counties, to provide for those not in the workforce. Such pressure is especially high in regions such as South Central Los Angeles, where jobs are harder to come by, as indicated in Figure 5-4 (a).

Figure 5-4 (a): Jobs per Working-Age Adult by Sub-County Region, 2016

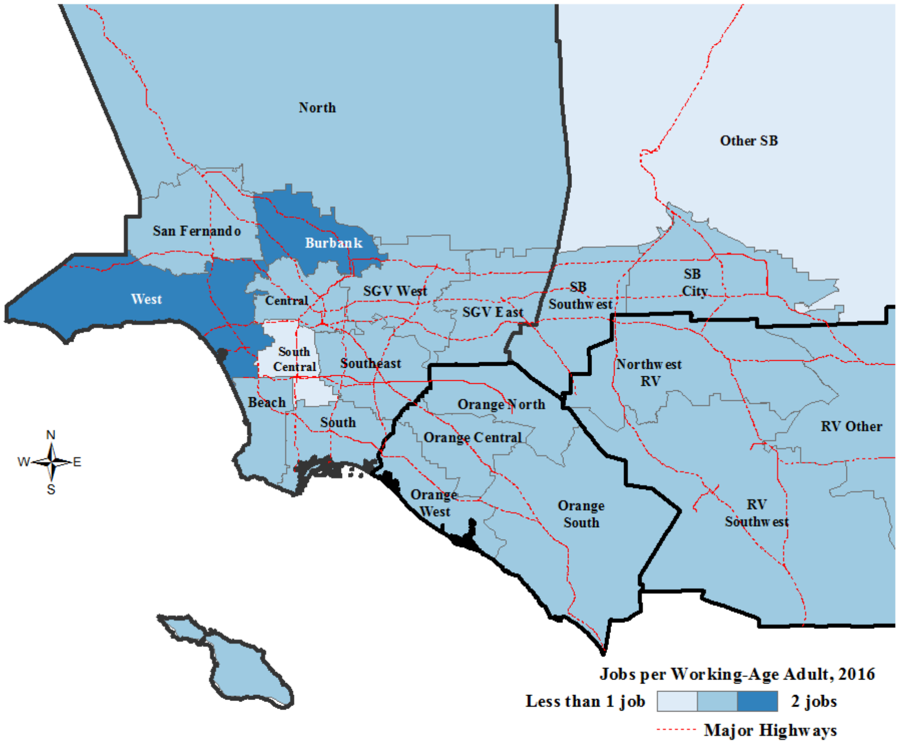
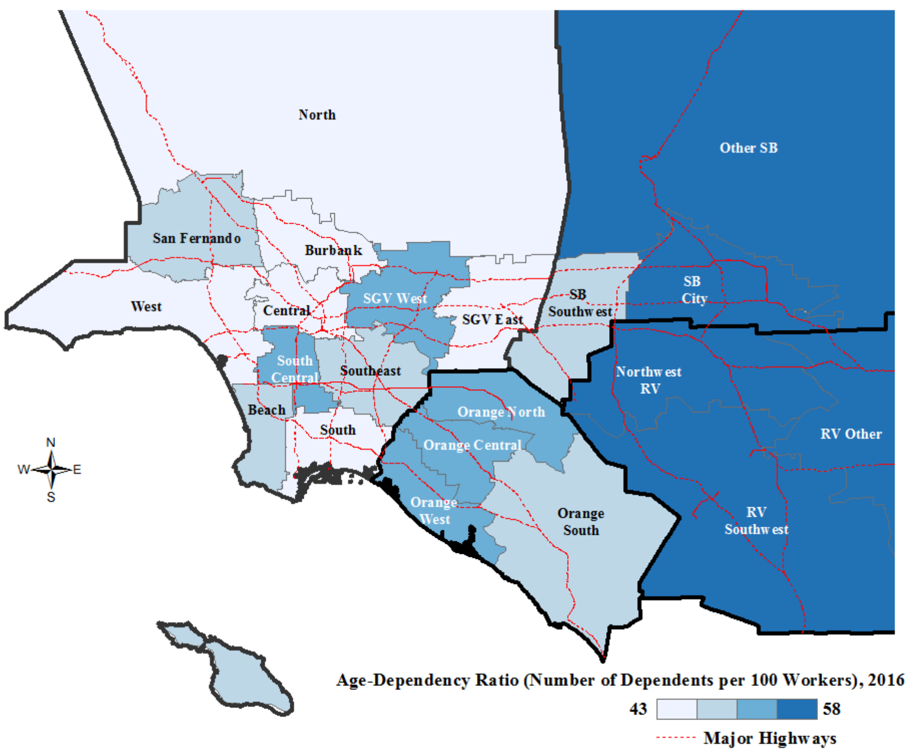


Figure 5-4 (b): Age-Dependency Ratios by Sub-County Region, 2016



In terms of economic output, Figure 5-5 (a) shows the distribution of industry output by sub-county region, with all dollar amounts being expressed in 2015 dollars. More than a quarter of the region's output, or about $420 billion, is generated in Central and West Los Angeles and Orange South; whereas, all sub-regions in Riverside and San Bernardino combined produced about $240 billion, or approximately 15 percent of the regional economic output. Figure 5-5 (b) illustrates different labor productivity across sub-county regions. Output per worker is highest in the beach and southern area of Los Angeles, with about $230,000 and $208,000 being generated per worker in 2016, respectively. The lowest levels of output per worker are in inland, with a range of about $130,000 being generated per worker in Other San Bernardino to about $150,000 in San Bernardino Southwest. The differences largely reflect the very different industry structures across the four-county region, with more capital-intensive industries tending to locate in the coastal counties and more labor-intensive industries in the inland area.

Figure 5-5 (a): Economic Output by Sub-County Region, 2016

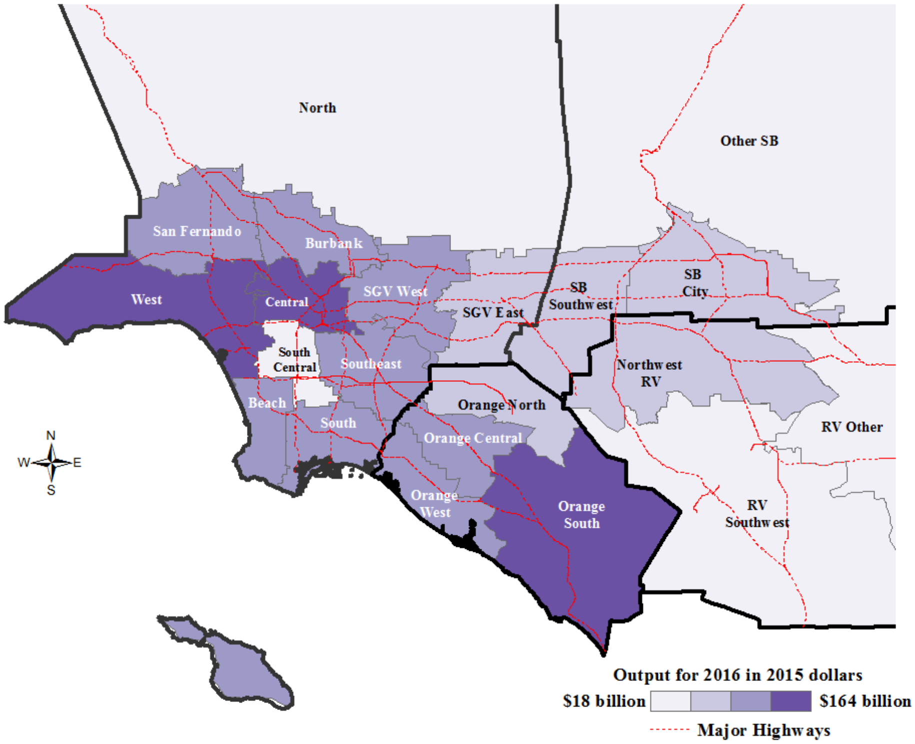
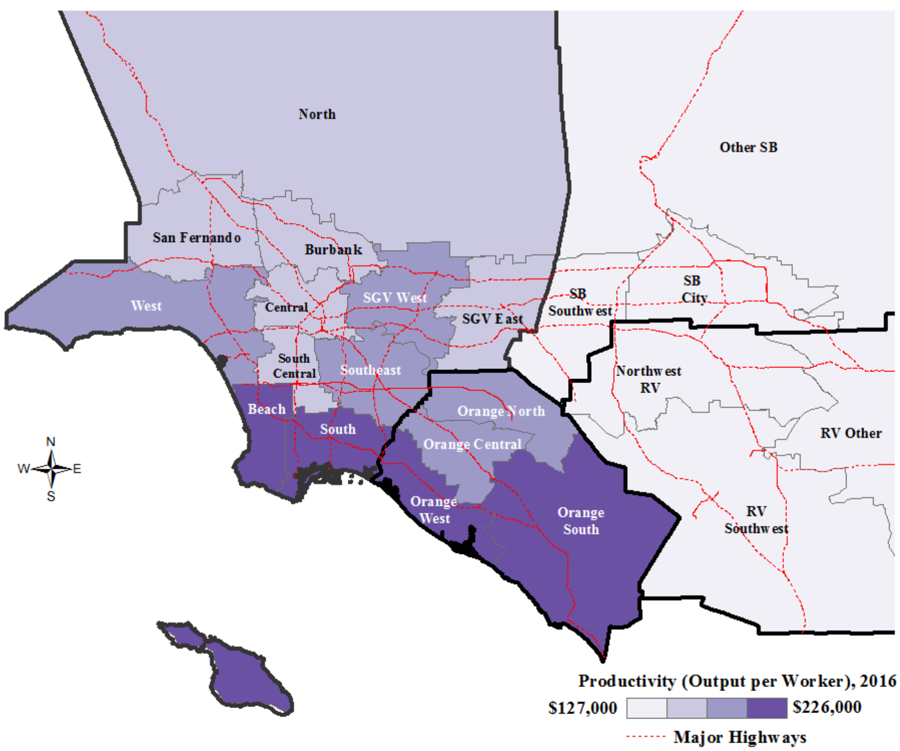


Figure 5-5 (b): Worker Productivity by Sub-County Region, 2016



Sub-County Distribution of Incremental Costs

As reported in Chapter 2, the present worth value of the total incremental cost associated with the Revised Draft 2016 AQMP is $15.5 billion. From 2017 to 2031, private industries, consumers, and the public sector will collectively spend an average of $1.4 billion each year. Table 5-1 reports the average annual total incremental costs by sub-county region, which range from a high of $106 million in San Fernando Los Angeles to a low of $36 million in Orange North (also illustrated in Figure 5-6). On a per capita basis, the range of average annual incremental costs narrows to a high of $92 per person in Southwestern Riverside to a low of $77 per person in Southeast Los Angeles and Beach and Catalina.[3]

Table 5-1: Total and Per Capita Incremental Cost by Sub-County Region[4] (Average Annual, 2017-2031)

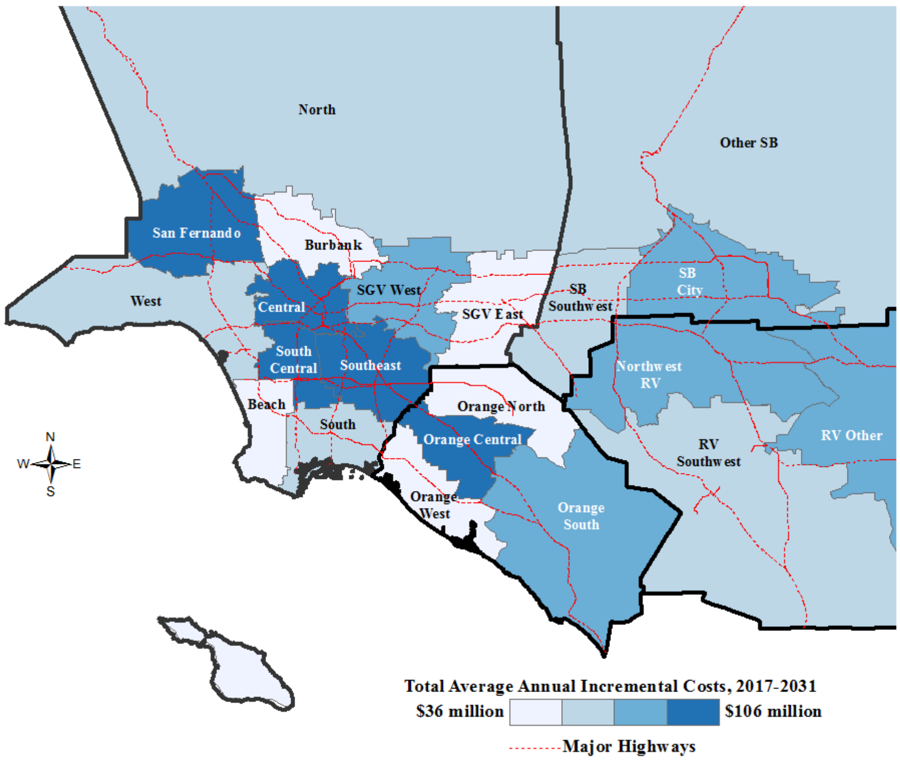
County	Sub-County Region	Total Average Annual Incremental Cost ($Millions)	Per Capita Average Annual Incremental Costs ($)
Los Angeles	Beach & Catalina	45	77
Los Angeles	Burbank	46	78
Los Angeles	Central	103	82
Los Angeles	North	61	87
Los Angeles	San Fernando	106	79
Los Angeles	San Gabriel Valley East	52	79
Los Angeles	San Gabriel Valley West	76	78
Los Angeles	South	69	78
Los Angeles	South Central	83	79
Los Angeles	Southeast	92	77
Los Angeles	West	71	80
Orange	Orange Central	82	78
Orange	Orange North	36	81
Orange	Orange South	82	83
Orange	Orange West	53	78
Riverside	Northwest Riverside	74	82
Riverside	Riverside Other	72	91
Riverside	Riverside Southwest	61	92
San Bernardino	Other San Bernardino	54	87
San Bernardino	San Bernardino City	71	82
San Bernardino	San Bernardino Southwest	54	84
All Sub-County Regions		**1,443**	**79**

Note: Total average annual incremental cost may not add up to the total in Table 2-1 due to rounding.

[3] Per capita calculation uses SCAG-adjusted REMI population projection data for 2016. Therefore, differing population growth in each sub-county region may also contribute to the differences of annual average per capita incremental cost observed across the sub-county regions.

[4] It should be noted that the cost distribution presented here is for informational purposes only, and mostly reflects sub-county per capita population distribution of the incremental costs. It may not reflect the actual cost distribution under all plausible cost scenarios. Staff expects to be able to gather more detailed information during the program implementation and rulemaking process.

Figure 5-6: Total Incremental Costs by Sub-County Region (Average Annual, 2017-2031)



Sub-County Distribution of Monetized Health Benefits

As discussed in Draft Appendix I of the 2016 AQMP, air pollution continues to be linked to increases in death rates (mortality) and increases in illness and other health effects (morbidity). Based on the quantification of health benefits in Chapter 3, it has been estimated that the four-county region will gain a total public health benefit of $256 billion in present worth value, which represents an average annualized benefit of $24 billion from 2017 to 2031 for the avoided incidence of mortality and morbidity.

Tables 5-2 and 5-3 report the total and per capita annual average public health benefits for each of the 21 sub-county regions, respectively. The per capita public health benefits will be further analyzed between EJ and non-EJ communities in Chapter 6. Mortality-related benefits associated with reduced long-term exposure to PM2.5 make up the vast majority, or over 99 percent, of total public health benefits quantified, and they range from an annual average of $3 billion in Central Los Angeles to $144 million in Other San Bernardino. As public health benefits were calculated based on reduced health risk per person, the $3 billion of public health benefits projected for Central Los Angeles does not only reflect the larger reductions in PM2.5 concentrations estimated in and around that area, but also its population size which is among the largest in the four-county region (see Chapter 3 and Figure 5-2(a)). That is why, in per capita terms, the range narrows to $2,500 per person in Central Los Angeles and $230 per person in Other San Bernardino.[5]

Mortality-related benefits associated with reduced short-term exposure to ozone range from an annual average of $55 million in Northwest Riverside to $12 million in South Central Los Angeles, reflecting the larger reductions of ozone concentration in and around Northwest Riverside. In per capita terms, this becomes $61 dollars per person in Northwest Riverside and $2 per person in South Central Los Angeles.

Table 5-2: Total Public Health Benefits by 21 Sub-County Region (Average Annual, 2017-2031)

County	Sub-county Region	Average Annual PM2.5 Benefits ($Millions)		Average Annual Ozone Benefits ($Millions)		Total Annual Average Benefits ($Millions)
		Mortality	Morbidity	Mortality	Morbidity	
Los Angeles	Beach & Catalina	833	7	18	2	861
Los Angeles	Burbank	712	6	21	3	741
Los Angeles	Central	3,106	29	27	4	3,166
Los Angeles	North	183	2	30	5	220
Los Angeles	San Fernando	1,493	13	54	9	1,570
Los Angeles	San Gabriel Valley East	968	9	31	5	1,013
Los Angeles	San Gabriel Valley West	1,964	16	29	4	2,014
Los Angeles	South	1,119	11	20	4	1,154
Los Angeles	South Central	1,650	19	12	3	1,684
Los Angeles	Southeast	2,040	22	24	5	2,091
Los Angeles	West	2,000	16	31	4	2,051
Orange	Orange Central	1,094	13	28	6	1,140
Orange	Orange North	593	5	18	3	619
Orange	Orange South	748	7	48	8	810
Orange	Orange West	994	8	28	4	1,034
Riverside	Northwest Riverside	941	9	55	10	1,015
Riverside	Riverside Other	195	1	37	5	238
Riverside	Riverside Southwest	402	3	39	6	450
San Bernardino	Other San Bernardino	144	1	31	5	181
San Bernardino	San Bernardino City	810	8	51	9	878
San Bernardino	San Bernardino Southwest	885	9	37	6	936
All Sub-County Regions		**22,878**	**213**	**669**	**107**	**23,867**

5 Per capita calculation uses SCAG-adjusted REMI population projection data for 2016. Therefore, differing population growth in each sub-county region may also contribute to the differences of annual average per capita public health benefits observed across the sub-county regions.

Table 5-3: Per Capita Public Health Benefits by 21 Sub-County Region (Average Annual, 2017-2031)

County	Sub-county Region	Per Capita Average Annual PM2.5 Benefits ($)		Per Capita Average Annual Ozone Benefits ($)		Total Annual Average Benefits Per Capita ($)
		Mortality	Morbidity	Mortality	Morbidity	
Los Angeles	Beach & Catalina	1,419	13	31	4	1,467
Los Angeles	Burbank	1,204	9	36	5	1,255
Los Angeles	Central	2,473	23	22	3	2,521
Los Angeles	North	261	3	42	8	314
Los Angeles	San Fernando	1,117	10	41	6	1,174
Los Angeles	San Gabriel Valley East	1,461	13	47	7	1,528
Los Angeles	San Gabriel Valley West	2,037	17	30	4	2,088
Los Angeles	South	1,267	13	23	4	1,307
Los Angeles	South Central	1,564	18	11	2	1,595
Los Angeles	Southeast	1,708	18	20	4	1,751
Los Angeles	West	2,252	18	35	4	2,308
Orange	Orange Central	1,035	12	26	6	1,079
Orange	Orange North	1,319	12	40	7	1,378
Orange	Orange South	756	7	48	8	818
Orange	Orange West	1,463	11	41	5	1,520
Riverside	Northwest Riverside	1,036	10	61	11	1,117
Riverside	Riverside Other	247	2	47	6	301
Riverside	Riverside Southwest	606	5	59	9	680
San Bernardino	Other San Bernardino	233	2	50	8	292
San Bernardino	San Bernardino City	931	9	59	10	1,008
San Bernardino	San Bernardino Southwest	1,377	13	57	10	1,457
All Sub-County Regions		**1,286**	**12**	**38**	**6**	**1,341**

Figures 5-7 (a) and (b) provide a visualization of how mortality-related benefits are distributed in the region. Figure 5-7 (a) shows that the largest average annual mortality-related benefits associated with decreased PM2.5 exposure are concentrated around Central Los Angeles; whereas, Figure 5-7 (b) shows that the largest average annual mortality-related benefits associated with decreased ozone exposure spread towards San Fernando Los Angeles, Orange South, and inland towards Northwest Riverside and San Bernardino City.

Morbidity-related benefits related to decreased PM2.5 and ozone exposure are much lower than mortality-related benefits and are similar to the spatial distributions shown in Figures 5-7(a) and (b), respectively. Together, the highest morbidity-related benefits are in Central Los Angeles, with an annual average of $33 million, and lowest in Riverside Other and Other San Bernardino with an annual average of $6 million. This translates into a $26 benefit per person and $8 to $10 benefit per person, respectively.

Figure 5-7 (a): Distribution of Mortality-Related Benefits for PM2.5 by Sub-County Region (Average Annual, 2017-2031)

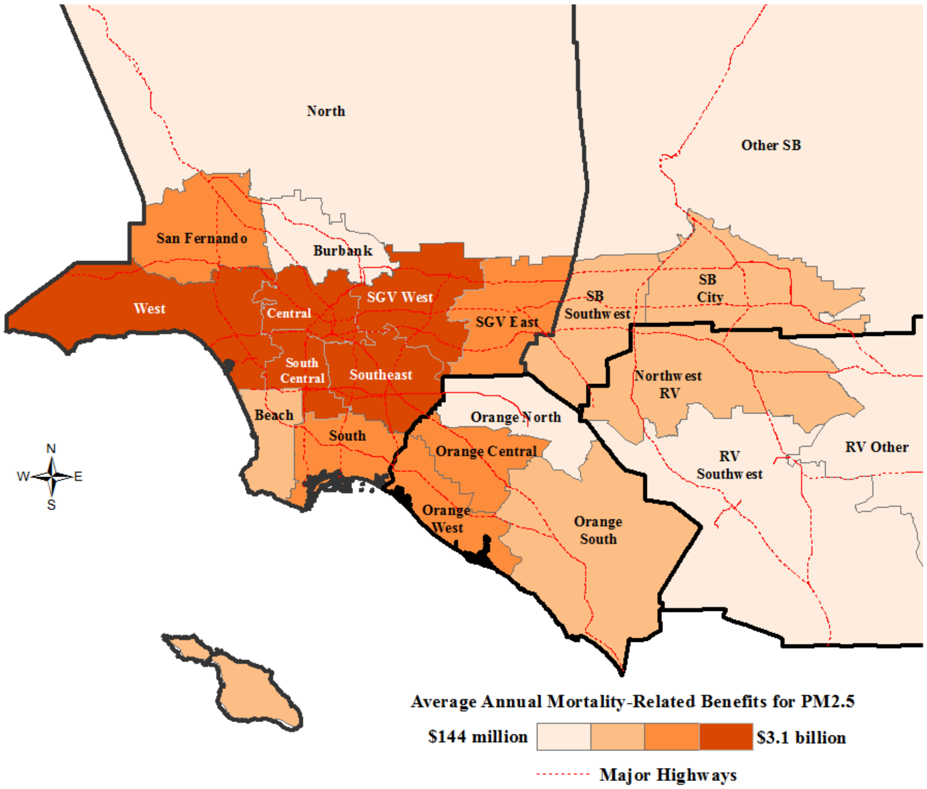
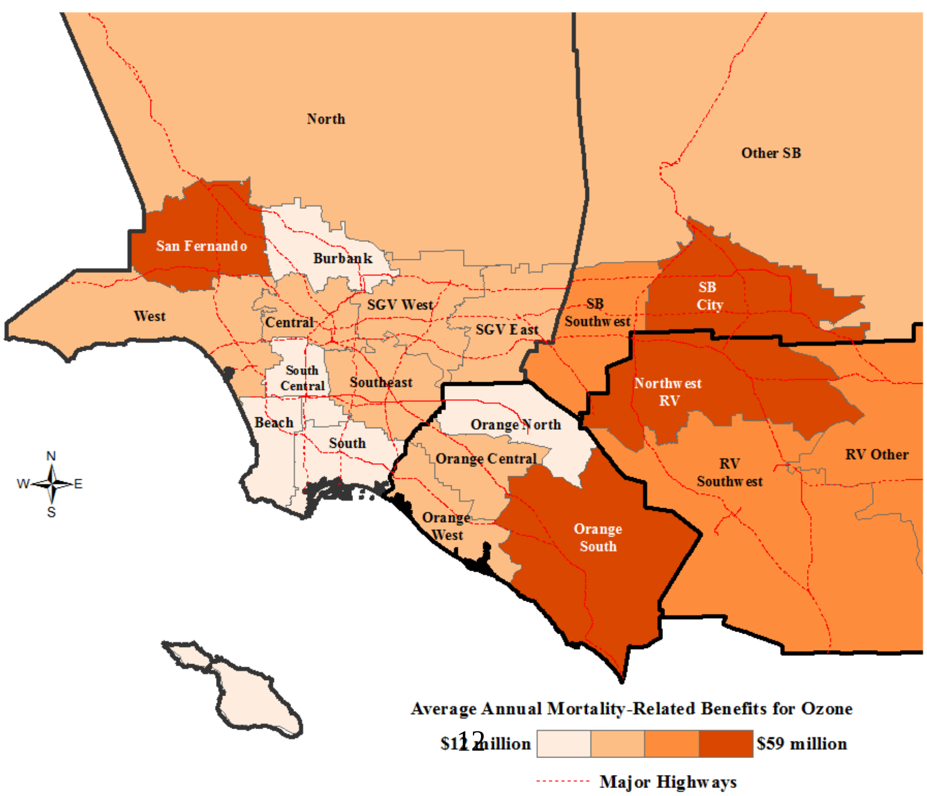


Figure 5-7 (b): Distribution of Mortality-Related Benefits for Ozone by Sub-County Region (Average Annual, 2017-2031)



Sub-County Distribution of Net Job Impacts

As discussed in Chapter 4, the costs and benefits of the 2016 AQMP are expected to alter, to various degrees, the economic decisions made by households, businesses, and other economic actors. Some businesses would see production costs go up while other businesses would benefit from a greater demand for their services and technologies. For consumers who consider purchasing or replacing vehicles or certain household appliances, the proposed control strategies would also change or widen the range of product choices that differ in fuel types, energy efficiency, effective unit prices, and therefore payback periods. In the meantime, improved public health would contribute to higher labor productivity and reduce healthcare-related expenditures. All these direct effects would then cascade through the regional economy and produce indirect and induced macroeconomic impacts. Given this, the region is expected to gain, on average, about 12,000 jobs per year as a result of implementing the Revised Draft 2016 AQMP.

Figure 5-8 (a) shows the distribution of the annual average net job impacts by sub-county region. Central Los Angeles is expected to gain the largest number of jobs at nearly 2,000 on average per year. Northwest Riverside and San Bernardino Southwest are also expected to gain a relatively large amount of jobs per year at about 1,600 and 1,150 respectively. The largest number of jobs foregone are expected in Orange South at about 130 jobs foregone on average per year. Figure 5-8 (b) shows the average annual percent change in jobs compared to the baseline, which represents job impacts that would occur regardless of whether the 2016 AQMP is implemented. The largest percent increases are concentrated in the Inland Empire and South Central Los Angeles and range from a 0.01 percent job increase in Burbank Los Angeles to 0.30 percent job increase in South Central Los Angeles relative to the baseline. Job decreases relative to the respective baseline forecasts is observed among several sub-county regions, with a -0.03 percent decline in jobs relative to the baseline in Riverside Other and slightly lesser declines in Orange Central, Orange South, and Los Angeles North.

Figure 5-8 (a): Distribution of Net Job Impacts by Sub-County Region (Annual Average, 2017-2031)

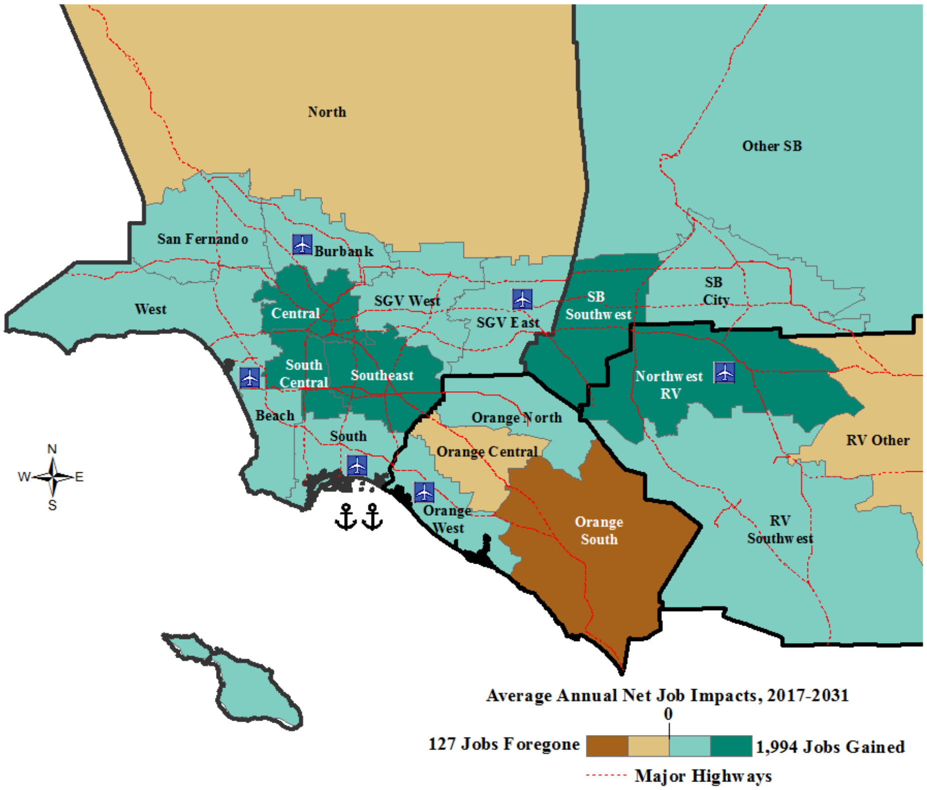
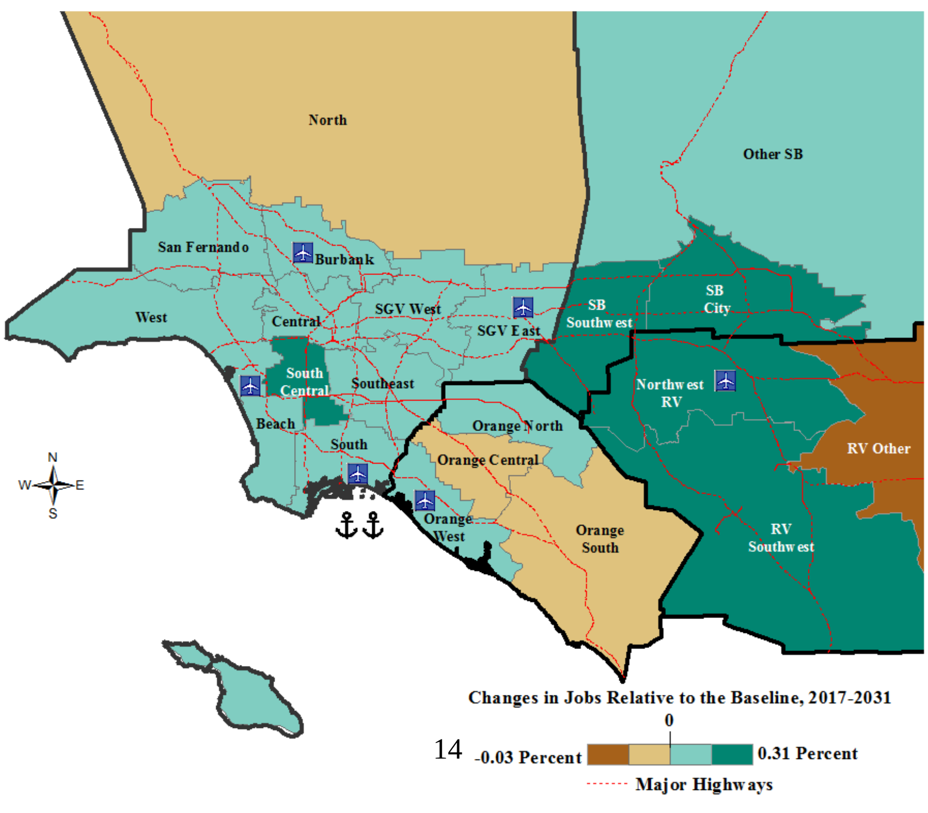


Figure 5-8 (b): Percent Change Relative to the Baseline by Sub-County Region (Annual Average, 2017-2031)



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Chapter 7: CEQA Alternatives

Preface

The projected incremental costs and job impacts of the CEQA Alternatives analyzed herein are preliminary and subject to future revision. Any potential revision is expected to relate to revisions to the CEQA alternatives included in the Draft Program Environmental Impact Report or the projected incremental costs quantified in Chapter 2.

The California Environmental Quality Act (CEQA) requires that the SCAQMD propose alternatives to the 2016 AQMP. These alternatives should include realistic measures to attain the basic objectives of the project (i.e., the obligation to adopt attainment plans to meet the PM2.5 and ozone NAAQS) and provide the means for evaluating the comparative merits of each alternative. The range of alternatives must be sufficient to permit a reasoned choice but need not include every conceivable project alternative. The key issue is whether the selection and discussion of alternatives fosters informed decision making and public participation.

The Draft Program Environmental Impact Report (PEIR) considers four CEQA Alternatives to the proposed 2016 AQMP.[1] For purposes of socioeconomic impact assessment, except for Alternative 1—No Project, it is assumed that the remaining three alternatives would lead to attainment of federal air quality standards (NAAQS). Each of the four alternatives and how their socioeconomic impacts were modeled are described below.

Description of CEQA Alternatives

Alternative 1—No Project

CEQA requires the evaluation of the No Project Alternative, which consists of what would occur if the proposed project was not approved; in this case, not adopting the 2016 AQMP. The net effect of not adopting the 2016 AQMP would be a continuation of the 2012 AQMP and the 2007 AQMP. This approach is consistent with CEQA Guidelines §15126.6 (e)(3)(A), which states: "When the project is the revision of an existing land use or regulatory plan, policy or ongoing operation, the ‘no project’ alternative will be the continuation of the existing plan, policy, or operation into the future. Typically this is a situation where other projects initiated under the existing plan will continue while the new plan is developed. Thus, the projected impacts of the proposed plan or alternative plans would be compared to the impacts that would occur under the existing plan”.

The No Project Alternative would implement any remaining control measures in the 2012 AQMP and fulfill the “black box” measure commitment in the future pursuant to the 2007 AQMP to achieve the 1997 8-hour ozone standard (80 ppb) by 2023 but would not propose enough reductions to achieve the 2008 8-hour ozone standard (75 ppb) by 2031 or the 2012 annual PM2.5 standard (12.0 $\mu g/m^3$) by

[1] Environmental Audit Inc. and Inabinet 2016; available at: http://www.aqmd.gov/docs/default-source/ceqa/documents/aqmd-projects/2016/2016-aqmp-draft-program-eir-combined.pdf?sfvrsn=2.

2025 as projected to be accomplished by the 2016 AQMP. Since no emission reductions are expected from the projected baseline inventory, there will be no emission reduction related costs or public health benefits, therefore also no resultant macroeconomic impacts under Alternative 1. However, the No Project Alternative would not be sufficient to satisfy the SCAQMD's SIP obligations. As discussed in Chapter 1, the receipt of federal highway funding for transportation investment in the region hinges on adopting an appropriate plan to attain the NAAQS; therefore, failure to do so could have undesirable economic consequences for the region. The potential macroeconomic impacts resulting from such a scenario are not quantified in this report due to a wide range of uncertainties regarding sanction implementation and impacts. For instance, the baseline economic projections used in the analysis relies on the 2016 SCAG Growth Forecast, which assumes that the region would continue receiving federal highway funding. Thus, analyzing the economic impacts of this potential funding shortfall would require new transportation and air quality model forecasts, which is beyond the scope of this report.

Alternative 2—Mobile Source Emission Reductions Only

Alternative 2 retains all mobile source control strategies proposed by the SCAQMD and CARB, along with CARB's consumer product control measure; however, the stationary source control measures as proposed by SCAQMD would not be implemented under this alternative. For the purpose of conducting a comparable socioeconomic analysis between the Draft 2016 AQMP and the CEQA alternatives, the amount of NOx emission reductions attributable to stationary source control measures under the proposed 2016 AQMP—8 tons and 20 tons per day in 2023 and 2031, respectively—would then be classified as achievable under CAA §182(e)(5) measures under Alternative 2, in order to still meet the ozone NAAQS. It was assumed that attainment of the 2012 annual PM2.5 standard would be achieved with implementation of all ozone control strategies, similar to the conclusion made in the 2016 AQMP.

Table 7-1 presents the list of Alternative 2 control measures, for which emission reductions were quantified. Again, for socioeconomic assessment purposes, it was further assumed that the CAA §182(e)(5) measures under Alternative 2 would be similar in nature to the mobile source control strategies that propose further deployment of cleaner technologies for on-road heavy duty vehicles, off-road equipment, and off-road federal and international sources. Therefore, a weighted average of cost-effectiveness of these three control strategies, at $29,000 per ton,[2] was used to evaluate the total incremental cost of the CAA §182(e)(5) measures. Overall, the annualized incremental cost of Alternative 2 is estimated to be approximately $1.3 billion per year between 2017 and 2031, which is about $150 million less costly than the incremental cost of the 2016 AQMP.[3] However, it should be noted that this result highly depends on the average cost-effectiveness of $29,000 per ton assumed, which is lower than the $40,000 to $50,000 per ton of cost-effectiveness estimated for stationary source control measures. However, it is likely that *additional* mobile source measures beyond those proposed in the 2016 AQMP will be more costly than the average cost, given that the lower cost options would presumably be exhausted first. Therefore, these results should be treated with sufficient caution.

[2] Using the DCF method.
[3] The annualized incremental cost for stationary source control measures was estimated at $253.8 million. In comparison, based on the cost-effectiveness assumption of $29,000 per ton, the annualized incremental cost of the CAA §182(e)(5) measures was estimated at $101.6 million.

Table 7-1: Control Measures Considered for Socioeconomic Assessment under Alternative 2

Measure	Title	Implementation Agency
MOB-10	Extension of the SOON Provision for Construction/Industrial Equipment [NOx]	SCAQMD
MOB-11	Extended Exchange Program [VOC, NOx, CO]	SCAQMD
MOB-14	Emission Reductions from Incentive Programs [NOx, PM]	SCAQMD
ORLD-01	Advanced Clean Cars 2	CARB
ORLD-03	Further Deployment of Cleaner Technologies: On-Road Light Duty Vehicles*	CARB
ORHD-02	Low-NOx Engine Standard – California and Federal Action	CARB
ORHD-04	Advanced Clean Transit	CARB
ORHD-05	Last Mile Delivery	CARB
ORHD-09	Further Deployment of Cleaner Technologies: On-Road Heavy Duty Vehicles	CARB
ORFIS-01	More Stringent National Locomotive Emission Standards	U.S. EPA
ORFIS-02	Tier 4 Vessel Standards	U.S. EPA
ORFIS-04	At-Berth Regulation Amendments	CARB
ORFIS-05	Further Deployment of Cleaner Technology: Off-Road Federal and International Sources	CARB
OFFS-01	Zero Emission Off-Road Forklift Regulation Phase 1	CARB
OFFS-04	Zero Emission Airport Ground Support Equipment	CARB
OFFS-05	Small Off-Road Engines	CARB
OFFS-07	Low-Emission Diesel Requirement	CARB
OFFS-08	Further Deployment of Cleaner Technologies: Off-Road Equipment	CARB
CPP-01	Consumer Products Program	CARB
CAA §182(e)(5) Measures (to Replace Stationary Source Control Measures)		

*NOx and VOC emission reductions estimated for this measure are considered as co-benefits.

<u>Alternative 3—CARB and SCAQMD Regulations Only</u>

Alternative 3 is designed to implement those control strategies that are regulatory in nature only. These strategies are proposed by both SCAQMD and CARB for stationary, area, and mobile sources, and include some measures regulating federal sources. Consequently, the emission reductions projected to be generated by incentive-based control strategies would be classified as achievable under CAA §182(e)(5) measures to meet the federal air quality standards. For socioeconomic analysis purposes, it was assumed that the CAA §182(e)(5) measures under Alternative 3 would be similar in nature to the incentive-based control strategies proposed in the Revised Draft 2016 AQMP, except that no incentives would be provided. In other words, Alternative 3 would retain all proposed control strategies under the 2016 AQMP. However, all emission reductions quantified for each control measure would be achieved via rule-making only.

Table 7-2 presents the list of Alternative 3 control measures, for which emission reductions were quantified. By way of assumptions made, the total incremental cost estimates remain the same under Alternative 3 as under the 2016 AQMP, annualized to $1.4 billion per year between 2017 and 2031. However, the incentive portion of the cost under the 2016 AQMP was now assumed to be incurred directly by the affected industries and consumers under Alternative 3.

Table 7-2: Control Measures Considered for Socioeconomic Assessment under Alternative 3

Measure	Title	Implementation Agency
BCM-01	Further Emission Reductions from Commercial Cooking [PM]	SCAQMD
BCM-04	Emission Reductions from Manure Management Strategies [NH3]	SCAQMD
BCM-10	Emission Reductions from Greenwaste Composting [VOC, NH3]	SCAQMD
CMB-03	Emission Reductions from Non-Refinery Flares [NOx,VOC]	SCAQMD
CMB-02	Emission Reductions from Replacement with Zero or Near-Zero NOx Appliances in Commercial and Residential Applications	SCAQMD
CMB-04	Emission Reductions from Restaurant Burners and Residential Cooking [NOx]	SCAQMD
CTS-01	Further Emission Reductions from Coatings, Solvents, Adhesives, and Sealants [VOC]	SCAQMD
ECC-02	Co-Benefits from Existing Residential and Commercial Building Energy Efficiency Measures [NOx,VOC]*	SCAQMD
ECC-03	Additional Enhancements in Reducing Existing Residential Building Energy Efficiency [NOx,VOC]	SCAQMD
CMB-01	Transition to Zero & Near-Zero Emission Technologies for Stationary Sources [All Pollutants]	SCAQMD
CMB-05	Further NOx Reductions from RECLAIM Assessment [NOx]	SCAQMD
FUG-01	Improved Leak Detection and Repair [VOC]	SCAQMD
MOB-10	Extension of the SOON Provision for Construction/Industrial Equipment [NOx]	SCAQMD
MOB-11	Extended Exchange Program [VOC, NOx, CO]	SCAQMD
MOB-14	Emission Reductions from Incentive Programs [NOx, PM]	SCAQMD
ORLD-01	Advanced Clean Cars 2	CARB
ORHD-02	Low-NOx Engine Standard – California and Federal Action	CARB
ORLD-03	Further Deployment of Cleaner Technologies: On-Road Light Duty Vehicles*	CARB
ORHD-04	Advanced Clean Transit	CARB
ORHD-05	Last Mile Delivery	CARB
ORHD-09	Further Deployment of Cleaner Technology: On-Road Heavy Duty Vehicles	CARB
ORFIS-01	More Stringent National Locomotive Emission Standards	U.S. EPA
ORFIS-02	Tier 4 Vessel Standards	U.S. EPA
ORFIS-04	At-Berth Regulation Amendments	CARB
ORFIS-05	Further Deployment of Cleaner Technology: Off-Road Federal and International Sources	CARB
OFFS-01	Zero Emission Off-Road Forklift Regulation Phase 1	CARB
OFFS-04	Zero Emission Airport Ground Support Equipment	CARB
OFFS-05	Small Off-Road Engines	CARB
OFFS-07	Low-Emission Diesel Requirement	CARB
OFFS-08	Further Deployment of Cleaner Technologies: Off-Road Equipment	CARB
CPP-01	Consumer Products Program	CARB

* NOx and/or VOC emission reductions estimated for these measures are considered as co-benefits.

Alternative 4—Expanded Incentive Funding

Alternative 4 would expand the incentive funding programs to accelerate the deployment of cleaner vehicles and technologies, potentially allowing for more emission reductions and possibly earlier attainment of NAAQS. Under this alternative, it was assumed that additional incentive funding sources would be found. For socioeconomic analysis purposes, it was further assumed that additional incentive funds would be available to achieve more NOx emission reductions under ECC-03 "Additional Enhancements in Reducing Existing Residential Building Energy Use" and further accelerate the deployment of facility-based clean technologies under CMB-01 "Transition to Zero and Near-Zero Emission Technologies for Stationary Sources". The list of Alternative 4 control measures, for which emission reductions were quantified, are the same as those listed in Table 7-2.

Incremental Cost Related Job Impacts of CEQA Alternatives

Table 7-3 compares the incremental costs and job impacts between the Revised Draft 2016 AQMP and the four CEQA alternatives. The annualized total incremental cost of the Revised Draft 2016 AQMP was estimated to be $1.4 billion per year between 2017 and 2031, which would result in an average of about 11,000 jobs foregone per year. As all CEQA alternatives, except the No Project Alternative, are required to be realistic and provide a viable path to attainment of NAAQS, their public health benefits are therefore expected to be fairly similar.

Table 7-3: Average Annual Incremental Costs and the Associated Job Impacts of AQMP and CEQA Alternatives, 2017-2031

Scenario	**Average Annual Incremental Costs** (Millions of 2015 Dollars)	**Average Annual Job Impacts Associated with Incremental Costs**
Revised Draft 2016 AQMP	$1,444	-11,284
Alt 1—No Project	Not Quantified	Not Quantified
Alt 2—Mobile Source Emission Reduction Only	$1,293	-7,553
Alt 3—CARB and SCAQMD Regulation Only	$1,444	-10,016
Alt 4—Expanded Incentive Funding*	TBD	TBD

* Staff is currently finalizing the socioeconomic impact assessment for Alternative 4.

As discussed above, while under the No Project Alternative there will be no emission reduction-related incremental cost and job impacts, it should be recognized that there could be potential federal sanctions under CAA, which would prohibit the region from receiving federal highway funding for regional transportation investment, and inhibit new business growth through more stringent emission offset requirements. Depending on the region's ability to make up for this lack of funding from other sources, federal sanctions could produce varying impacts on the regional economy, which are not quantified in this analysis as explained above.

Under Alternative 2—Mobile Source Emission Reduction Only, it was assumed that the stationary source control strategies would be replaced by the CAA §182(e)(5) measures that have similar cost-effectiveness as the mobile source control strategies that propose further deployment of cleaner technologies for on-road heavy duty vehicles, off-road equipment, and off-road federal and international sources. As a result of this assumption, Alternative 2 was estimated to be less costly than the Revised Draft 2016 AQMP, with an annualized total incremental cost of $1.3 billion per year between 2017 and 2031. Consequently, it would also result in fewer jobs foregone (on average about 7,500 per year) than the Revised Draft 2016 AQMP. But as noted above, the assumption of a similar cost-effectiveness for additional mobile source measures beyond the 2016 AQMP is highly uncertain and likely underestimates costs.

Under Alternative 3—CARB and SCAQMD Regulation Only, it was assumed that all control strategies would remain the same as proposed in the Revised Draft 2016 AQMP, except that all emission reductions would be achieved by rule-making and no incentives would be provided. As a result of this assumption, Alternative 3 was estimated to have the same total incremental cost as the Revised Draft 2016 AQMP, annualized at $1.4 billion per year between 2017 and 2031. However, it would result in an average of about 1,000 fewer jobs foregone. This is mainly due to the shifting of incremental costs from the state government, who was assumed to provide all incentive funding under the primary scenario of job impact analysis for the Revised Draft 2016 AQMP, to the affected industry sectors and consumers. As discussed earlier in Chapter 4, in the REMI model, the reallocation of public funds to the proposed clean air incentive programs would directly result in funds diverted from local spending and thus jobs foregone in many sectors of the regional economy. In comparison, in the case where the private industries and consumers incur the costs, they may reduce spending on other goods and services, some of which may be imported; consequently, the overall adverse effect on the region's level of employment would become slightly dampened.

[Place Holder for Alternative 4]

Chapter 8: Summary

Summary of Socioeconomic Analyses of the Revised Draft 2016 AQMP

The Revised Draft 2016 AQMP control strategy will seek emission reductions from stationary and mobile sources through command-and-control regulations and incentives to help accelerate the deployment of cleaner equipment for the purpose of achieving federal and state air quality standards. The total incremental cost of the Revised 2016 Draft AQMP was estimated to be $15.5 billion in present worth value (expressed in 2015 dollars). Between 2017 and 2031, the amortized annual average incremental cost would be $1.4 billion. About 60 percent or $9.1 billion of the total incremental cost is related to CARB mobile source control strategies affecting the Basin. About 36 percent or $5.7 billion is associated with SCAQMD control measures for stationary sources, and the remaining 4 percent or $0.6 billion represents the SCAQMD's local mobile source measures. The proposed incentives, in the amount of $14.4 billion, would be distributed to eligible industries and consumers and offset about 93 percent of the total incremental cost estimated for the Revised Draft 2016 AQMP.

Importantly, the region will also experience benefits from the implementation of the Revised Draft 2016 AQMP. Air pollution continues to be linked to increases in death rates (mortality) and increases in illness and other health effects (morbidity). It was estimated that, due to lower mortality and morbidity risks as a result of implementing the Revised Draft 2016 AQMP, an estimated $256 billion worth of public health benefits are expected to accrue in the four-county region from 2017 to 2031. This represents an average of $24 billion in public health benefits per year. Over 99 percent of the estimated public health benefits are associated with avoided premature deaths from reduced long-term exposure to PM2.5. Although not quantified in this report, there exist additional public welfare benefits related to clean air from preventing damage to agriculture, ecology, visibility, buildings, and materials.

The incremental costs and public health benefits of the Revised Draft 2016 AQMP are expected to alter, to various degrees, the economic decisions made by households, businesses, and other economic actors. Some businesses would see production costs go up while other businesses would benefit from a greater demand for their services and technologies. For consumers who consider purchasing or replacing vehicles or certain household appliances, the proposed control strategies would also change or widen the range of product choices that differ in fuel types, energy efficiency, effective unit prices, and therefore payback periods. Improved public health would contribute to higher labor productivity and reduce healthcare-related expenditures, while also increasing the region's attractiveness to economic migrants. All these direct effects would then cascade through the regional economy and would produce indirect and induced macroeconomic impacts.

As a result of incremental costs and health benefits associated with the Revised Draft 2016 AQMP, the overall job impact on the four-county region of Los Angeles, Orange, Riverside, and San Bernardino is projected to range from 11,000 jobs foregone to 27,000 jobs gained per year from 2017 to 2031, relative to the baseline employment forecast where the 2016 AQMP control strategies are not implemented. In an economy with nearly 18 million people and more than 10 million jobs, the projected changes in employment levels are expected to have minimal impact on the region's employment growth during the same period. The region's projected annualized job growth rate will remain at slightly above one percent (1.01 to 1.04 percent) under all 2016 AQMP scenarios examined for macroeconomic impact modeling.

Under the primary scenario (i.e., incentives funded by existing state revenue sources and full air-related public health benefits for regional amenity adjustments), the region is expected to gain an average of about 12,000 jobs per year from 2017 to 2031. This represents an annualized job growth rate of 1.04 percent, or a 0.02 percentage point acceleration from the baseline employment growth over the same period. In the beginning years, however, large amounts of incentives would directly result in funds diverted from local spending and thus jobs foregone in many sectors of the regional economy, among which state and local governments would be most adversely impacted, followed by construction, retail trade, and healthcare and social assistance sectors. Over time, as the proposed control strategies are implemented and public health benefits are realized, increased regional amenity is expected to attract more economic migrants and enlarge the pie of the regional economy, thereby creating more job opportunities in the four-county region.

It should be noted, however, there remains methodological uncertainties regarding macroeconomic modeling of non-market benefits and how clean air related amenities should be weighted relative to other regional amenities (Abt Associates 2014; Lahr 2016); therefore, the result of positive net impact should be regarded with caution. Nonetheless, it should also be noted that, even with the most conservative approach where public health benefits are considered as having no impacts on the regional economy, the projected 2017-2031 annual average job impacts associated with incremental cost only would represent one-tenth of a percent decrease in employment levels from the forecast baseline. This represents less than 0.01 percentage point slowdown for the annualized job growth rate, to 1.01 percent, over the same period. Moreover, as shown in Chapter 4, this slightly negative impact could be potentially mitigated if incentive funding can be obtained from outside the region or state.

To provide stakeholders with more information about how the Revised Draft 2016 AQMP would potentially impact different sub-county communities within the region, sub-regional distributions for incremental costs, public health benefits, and net job impacts were also provided. The average annualized incremental costs between 2017 and 2031, if spread among the region's population, would range from approximately $36 million in Orange North, a sub-region of Orange County to $106 million in the San Fernando sub-region of Los Angeles County. The average annual public health benefits range from $181 million in Other San Bernardino, the northern sub-region of San Bernardino County, to $3.2 billion in the Central sub-region of Los Angeles County. Of the 12,000 jobs expected to be gained on average each year during the period of 2017-2031, Central Los Angeles is expected to see the largest gain of jobs, with nearly 2,000 jobs being added on average each year to the baseline forecast levels, while Orange South will see more than 100 jobs foregone on average each year during the same period.

In addition, the EJ analysis was significantly enhanced and expanded compared to previous AQMPs by investigating the distributional impact of the Revised Draft 2016 AQMP based on multiple alternative definitions of EJ communities. Specifically, staff examined whether estimated reductions in health risks associated with air pollution would reduce or exacerbate baseline inequality in the Basin. Inequality between EJ and non-EJ communities was also analyzed to identify any potential differential impact. First, as a result of implementing the Revised Draft 2016 AQMP, greater per-capita health benefits are anticipated to accrue in EJ communities than non-EJ communities. Next, in terms of the distribution of health risk related to air pollution exposure, inequality in mortality-related risk more likely to affect the elderly population was found to decrease overall, and also between the EJ and non-EJ communities. This finding is consistent for both mortality-related risk associated with long-term exposure to PM2.5 and short-term exposure to ozone. However, the inequality of morbidity risk for asthma-related ED visits among children with short-term exposure to ozone increased slightly between EJ and non-EJ communities despite a decrease in overall inequality. These general results do not change based on different EJ definitions.

Lastly, this report also examines the potential socioeconomic impacts of CEQA alternatives to the proposed 2016 AQMP. The Draft Program Environmental Impact Report (EIR) includes four alternatives: Alternative 1—No Project; Alternative 2—Mobile Source Emission Reductions Only; Alternative 3—CARB and SCAQMD Regulations Only; and Alternative 4—Expanded Incentive Funding. All the alternatives above, except the No Project Alternative, are required to be realistic and provide a viable path to attainment of federal air quality standards. Therefore, for Alternatives 2, 3, and 4, only incremental costs and the associated job impacts were analyzed and compared to the corresponding impacts of the proposed 2016 AQMP, as their public health benefits are expected to be fairly similar. For purposes of the socioeconomic assessment, Alternatives 2 and 3 were analyzed based on the assumption that they would lead to NAAQS attainment with CAA §182(e)(5) measures (i.e., "black box" measures). Incremental costs of both Alternatives 2 and 3 are projected to result in fewer jobs foregone than the proposed 2016 AQMP. Caution should be exercised, however, as the projected estimates are highly dependent on the assumptions made for each alternative. [Placeholder for impacts of Alt. 4]

Enhancements Made to the 2016 AQMP Socioeconomic Assessment

As mentioned in Chapter 1, Abt Associates conducted a review in 2014 of the SCAQMD's practices for conducting socioeconomic assessments for previous AQMPs during rulemaking. The key purpose was to evaluate whether these practices represented state-of-the-art methods for these assessments, whether the scope of the analysis undertaken was adequate, and whether the documentation assured a transparent and balanced presentation to reflect interests from different parties. As a result of the 2014 review, a concerted effort among staff, sister agencies, and the public has been made to enhance the development and documentation of the 2016 AQMP Socioeconomic Report.

First and foremost, this report is designed to be accessible and transparent to the general public. The main document presents the general picture of socioeconomic impacts while clearly defining methodologies employed and data sources utilized. Careful consideration has been given to report not only overall impacts, but to also discuss uncertainty and provide a range of estimates through sensitivity analyses.[1] When quantification of uncertainty is not feasible, a qualitative discussion

[1] This includes sensitivity analyses for health benefits in Chapter 3, macroeconomic modeling of non-market benefits in Chapter 4, macroeconomic modeling of different incentive funding scenarios in Chapter 4, and EJ community definitions and distributional analysis in Chapter 6.

about uncertainty sources, the expected magnitude, and impact of uncertainty (i.e. negative or positive effect on results) has been added. In addition, the appendices provide technical readers with more detail about the analyses, while an executive summary geared towards a more general audience condenses the analyses and results. As each component of the Draft 2016 Socioeconomic Report has been developed, it has been presented at various meetings to the STMPR Advisory Group, the AQMP Advisory Group, and the interested parties from the public to enhance transparency and solicit feedback. Staff also presented the preliminary outline of this report and described analysis methodologies at six AQMP scoping meetings in July 2016.

To implement Abt's recommendation to clearly define the baseline for socioeconomic analysis and clarify whether the baseline should include SCAG's transportation control measures (TCMs), staff worked closely with SCAG staff and consultants from REMI and the Center for Continuing Study of the California Economy. Following many rounds of communication and discussions, the consensus was reached that TCMs, along with other components of the 2016 RTP/SCS, should be considered as baseline for the AQMP socioeconomic assessment, and that, for informational purposes, the benefits and costs associated with TCMs would be provided separately in the 2016 AQMP Appendix IV-C: Regional Transportation Plan/Sustainable Communities Strategy and Transportation Control Measures. This baseline definition is also consistent with the AQMP baseline inventory of air pollutant emissions, which considers any emission reductions associated with SCAG's 2016 RTP/SCS and all its sub-components (TCMs included) as accounted for in the baseline. Additionally, as in the past, the default population and employment baseline forecasts in the REMI model were adjusted in accordance with the employment and population projections from SCAG's 2016 Growth Forecast, which was also largely used to project future baseline emissions of air pollutants.[2]

In order to improve the public health benefits analysis conducted in the socioeconomic assessment, the SCAQMD commissioned IEc to conduct an updated literature review of epidemiological studies to quantify concentration-response functions, which quantitatively describe the relationship between exposure to air pollution and various health endpoints, and economic valuation functions, which are used to monetize quantified public health benefits. Based on the review of literature, IEc provided staff with recommendations on which health endpoints to include in the public health benefits analysis of the 2016 AQMP and which mathematical functions should be used to evaluate and quantify benefits. IEc also provided recommendations on the use of the U.S. EPA's BenMAP tool, including choices of data input, assumptions and procedures that were appropriate for the functions used in the analysis. IEc recommendations and the analysis results were presented during each step of the process to the STMPR Advisory Group for review and guidance. In addition to IEc recommendations, the BenMAP operations were further reviewed and confirmed as appropriate by Dr. Jin Huang, former project manager for the 2014 Abt review and the STMPR expert on BenMAP analysis.

IEc also reviewed the most updated literature of environmental justice studies and analytical tools. Based on the review, IEc recommended alternative EJ screening definitions and the most appropriate screening tools that have been developed to help identify EJ communities for socioeconomic assessment purposes. Additionally, IEc also recommended the state-of-science methodology to analyze the impacts of the proposed 2016 AQMP on health risk distributions

[2] See Appendix 4-A for more discussion.

between and within EJ and non-EJ communities. To engage the community and develop the most applicable approach in the region, the 2016 AQMP Socioeconomic Assessment Environmental Justice Working Group was formed to review and provide comments and suggestions on IEc's recommendations and staff's analysis results. The Working Group's feedback helped inform and enhance the EJ analyses in this report.

Finally, the SCAQMD commissioned a third-party evaluation by Dr. Michael Lahr on REMI's modeling of non-market benefits and Abt's further recommendation to evaluate how to improve the input of these benefits into REMI. REMI models non-market benefits as an improvement to regional amenities, or quality of life; however, the 2014 Abt Report indicated that there remained methodological uncertainties as to how these benefits could be best incorporated into macroeconomic modeling and asked staff to keep abreast of developments at the U.S. EPA's Science Advisory Board Panel on Economy-Wide Modeling. While it is generally recognized that location-specific amenities such as climate, clean air, public safety, and other public service provisions, make a region more attractive to economic migrants, the 2014 Abt report also indicated that prospective economic migrants may consider air quality differently than other types of amenities when making their location choices; however, such differences, if any, were not taken into account under the prior modeling approach. As such, Abt recommended identifying methods to properly normalize the magnitude of adjustments made to the sub-region specific amenity coefficients in REMI's migration equation, which links air quality change with the relative attractiveness of one area compared to another. Based on the qualitative conclusion made in the third-party evaluation, staff conducted a sensitivity analysis of job impacts where the REMI input related to the non-market portion of public health benefits was discounted by half, therefore significantly lessening the magnitude of adjustments to the amenity coefficients in REMI. Staff preliminarily concluded that this adjustment is a major determinant to the non-market benefits related job impact; however, further research is needed to determine the proper scaling of the related REMI input.

Future Enhancements for Future AQMPs

Staff will continue working to update the technical aspects of its analyses which includes updating methodologies to quantify visibility, material, and agricultural benefits, developing methods to properly normalize the magnitude of adjustment to the amenity coefficient in REMI, evaluating the use of other modeling tools such as partial equilibrium modeling to supplement REMI for small scale impacts, updating best practices for estimating small business impacts, and closely monitoring the U.S. EPA Science Advisory Board's Economy-Wide Modeling Panel discussions and recommendations, particularly on the macroeconomic modeling of non-market benefits. Retrospective studies, when feasible, will be considered as part of the implementation plan to enhance the uncertainty analysis.

Appendix 4-A: REMI Baseline Adjustments for the 2016 AQMP

Introduction

The 2016 AQMP uses SCAG's 2016 Growth Forecast of employment, population, output, and other socioeconomic variables as inputs for baseline emissions inventories. To simulate the potential socioeconomic impacts of air pollution control policies, SCAQMD staff use the Regional Economic Models Inc. (REMI) model, which is embedded with its own demographic and economic forecasts. The REMI employment and population projections are consistent with SCAG at the national level, but differ for the four-county region of Los Angeles, Orange, Riverside, and San Bernardino. For consistency with other AQMP analyses, the sub-county employment and population forecasts by SCAG for the four-county region are used to adjust and update the REMI baseline forecast for the 2016 AQMP socioeconomic impact assessment. The following sections describe the data and methods used to accomplish the updates in the REMI model, as well as the updated results and any potential implications due to the updates performed.

REMI Baseline Update: Background and Assessment

A 1992 audit of the SCAQMD's socioeconomic analysis methods by Massachusetts Institute of Technology (MIT) recommended further evaluation of the inconsistency between the REMI and SCAG forecasts and the method used to resolve it (Polenske et al. 1992). The biggest source of inconsistency comes from the use of different employment data for the forecast, where SCAG relies on the Bureau of Labor Statistics (BLS), REMI uses data from the Bureau of Economic Analysis (BEA). The MIT report observed that job impacts predicted by the model could differ significantly between the default REMI and the adjusted REMI models and that this was undesirable. The suggestions offered were: (1) use the default version of REMI model if legally permissible, (2) if SCAG data best suits SCAQMD's needs, negotiate with REMI for a model based on BLS data if feasible, and (3) if the adjusted REMI model is used, the issue of differing job impacts would need to be considered during analysis.

Following the MIT audit, SCAQMD staff chose option (3) and commissioned a study from the Center for the Continuing Study of the California Economy (CCSCE) to determine the sources of inconsistency between these forecasts (Levy 1994). A three-step process was recommended to ensure consistency between REMI and SCAG forecasts: (1) they should use the same U.S. projections for population and employment, (2) they should use the same birth rates by age cohort; and (3) they should use similar rates of growth for employment projections. Since the completion of the CCSCE report, REMI and SCAG forecasts have converged in the data sources used for their respective national projections: the BLS Employment Outlook was primarily used for national employment projections, and the U.S. Census Bureau's national population projections was the basis for national population projections (REMI 2015a). As with the most recent AQMP socioeconomic reports (Lieu, Dabirian, and Kwon 2007; Lieu, Dabirian, and Hunter 2012), it was determined by SCAQMD staff that no further adjustment to the REMI U.S. forecast is needed.

In this report, SCAQMD staff took the recommendations by both MIT and CCSCE into consideration when conducting an update of the REMI model baseline (i.e., "Regional Control") with SCAG employment and population forecasts. As described in detail in the following sections, staff found that the REMI employment update achieved similar employment growth rates, by county and also for each of the 21 sub-county regions, to SCAG's forecast for the 2016-2031 analysis horizon. We also found that, by using the REMI Population Update function, the REMI population forecast was updated to be identical to SCAG's.

Having achieved the goals set forth by the CCSCE study, staff further investigated, based on the MIT recommendation, the effect of the update on the key parameter of labor productivity, which is the primary parameter in predicting the job impacts of a policy, as described below. Staff found that these updates did not significantly alter labor productivity parameters from the REMI default values; the values changed by less than one percent for the majority of sectors. Based on these findings, staff concluded that the updated REMI model, which was used for the socioeconomic analysis of the 2016 AQMP, acceptably reflected the population and employment growth rates forecasted by SCAG. Furthermore, the update did not result in significant changes to the key model parameter of labor productivity, and thus job impact predictions are not expected to differ significantly from what would have been predicted using the default REMI model.

Employment Baseline Adjustment

Data

The employment forecast in the REMI model and that from SCAG differ both in their data sources and their forecast of employment levels up to 2031. The REMI model uses employment data from BEA, supplemented by compensation data from the same source, for its historical employment pattern in the 21 sub-county regions contained in the model. For employment projections, REMI bases its national forecast on the 2012-2022 Employment Outlook published by the BLS, along with short-term final demand forecast by the Research Seminar in Quantitative Economics (RSQE). The national forecast is then converted to regional forecasts using historical patterns (REMI 2015a). In comparison, SCAG's employment forecast is based on data published by the California Employment Development Department (EDD) and the BLS. The base year of SCAG's forecast is 2012. The 2012 employment level is benchmarked to the corresponding historical data in the Current Employment Statistics (CES), and the forecasts for all future years were projected based on a shift-share calculation of national employment forecasts and refined by inputs provided to SCAG by their local jurisdictions.

There are several differences between the BEA and the EDD/BLS CES data. The BEA employment data uses additional data sources to estimate employment in the farm sector, private households, private schools, and other sectors such as railroad operations. The BEA data also include federal military jobs and estimates of self-employment based on tax records. In contrast, the BLS data report only civilian payroll employment. For transportation modeling purposes, SCAG arrived at its total employment projections by adding self-employment by sector based on the American Community Survey's Public Use Microdata Samples (ACS PUMS). This method results in much lower estimates of the self-employed than reported in the BEA data, as indicated by a comparison of the 2012 data.

Method

Based on the 2016 Final RTP/SCS (SCAG 2016), SCAG staff provided a forecast of levels of employment by sector for each of the 21 sub-county regions used within the REMI model, for 11 years between 2016 and 2031, in addition to the 2012 base year.[1] The provided data were based on a conversion from SCAG's employment forecast, which was for 13 industry sectors by Transportation Analysis Zone (TAZ),[2] to the REMI 70-sector model by 21 sub-county regions that was customized for the SCAQMD. The conversion was performed in consultation with SCAQMD staff so that the industry sectors and geographical boundaries are aligned with those in the REMI model. As part of this conversion, SCAG provided a forecast of the Public Administration sector (NAICS 92), which included federal civilian employment,[3] local and state government employment, as well as public school employment. In the REMI model, however, this sector has two separate categories for federal civilian employment and local and state government employment, with public school employment included within the latter category. In order to obtain an applicable growth rate for the REMI model, the Public Administration employment provided by SCAG was allocated into federal civilian and state and local government categories based on the relative employment share annually as implied by the REMI default forecast. Military and private household employment forecasts were not provided by SCAG; therefore, SCAQMD staff used the default forecast in REMI. Finally, for those years that are missing from the provided forecast, linear interpolation was used to estimate employment for these in-between years.

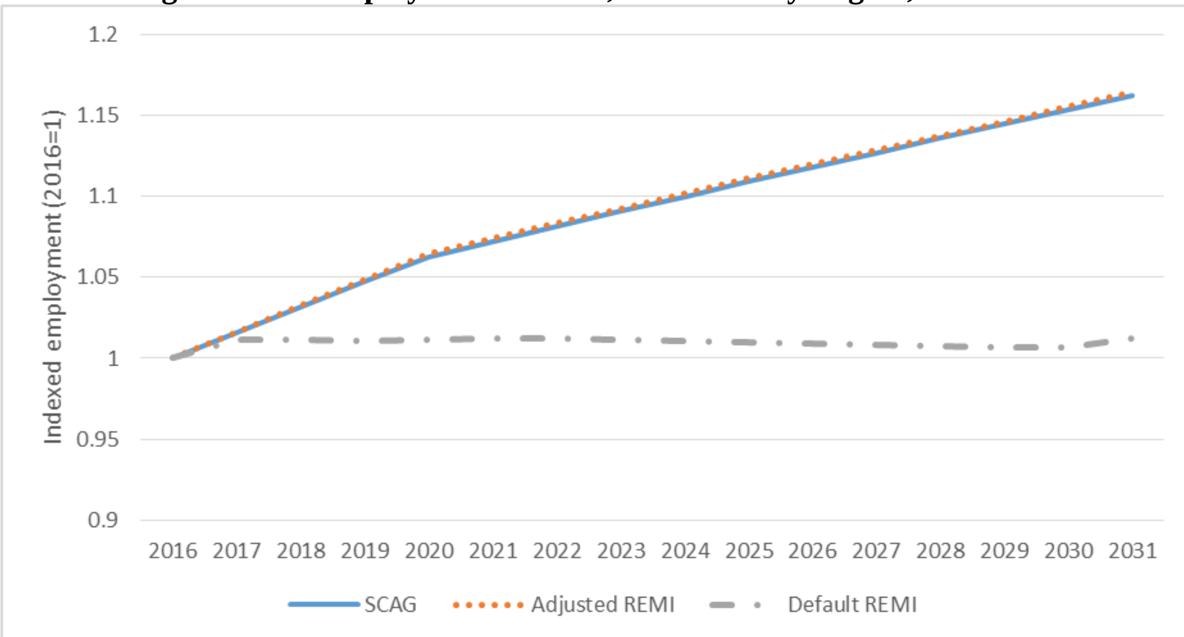
From these employment data, the yearly growth rate was calculated between 2013 and 2031 for each sub-county and each industry sector. These SCAG employment growth rates are then multiplied by the corresponding REMI employment level in 2013, the last year of historical data in the REMI model. This results in an employment forecast which begins with REMI's base employment level in 2013, and grows at the rate forecasted by SCAG. This adjusted employment forecast is entered into the REMI model using the Employment Update function. As illustrated in Figure 4A-3, the overall growth rate is nearly identical between the SCAG and the adjusted REMI forecasts. At the same time, the SCAG, and hence the adjusted REMI, employment growth is considerably more optimistic than the default REMI forecast. By 2031, the difference in the adjusted and default levels of overall employment in REMI reaches 15 percentage points.

[1] The years of employment and population data provided are 2012, 2016-2023, 2025, 2026, and 2031. The base year of 2012 was used in the analysis for both the 2016 AQMP and the 2016 RTP/SCS. Other years, except 2016, are the milestone years for air quality attainment demonstration.

[2] TAZs are generally equivalent to census block groups, and there are a total 11,267 TAZs in all of the SCAG counties except Catalina Island.

[3] Post office workers (NAICS 491) are also included here.

Figure 4A-3: Employment Growth, Four-County Region, 2016-2031



It should be noted that there are several technical constraints to directly applying SCAG's projected level of employment in REMI's Employment Update function. First, there are large differences in estimates of self-employment between those obtained from ACS PUMS and those from BEA. Secondly, regional allocation of jobs from aggregation of SCAG's TAZs and REMI's method may differ. These resulted in significant differences in the employment levels between REMI and SCAG forecasts. These large differences caused errors in the REMI model when SCAG employment levels were directly used in the Employment Update function. The employment growth rate method adopted here follows what was done in the previous AQMP (Lieu, Dabirian, and Hunter 2012), but is enhanced to include detailed growth rates by 21 sub-county regions and 70 industry sectors based on statistics directly projected by SCAG. Additionally, growth rates were calculated annually instead of for five-year periods.

Results and Implications

The 2016-2031 employment growth rates by county and by sector can be found in Tables 4A-1 and 4A-2, respectively. On average, the SCAG employment growth rate is greater than that of the REMI default rate over the 2016-2031 time period. While SCAG projected the four-county region to grow at an average annual rate of 0.9 percent, the REMI defaults forecasted a mere 0.1 percent. Examining Table 4A-2, it is also observed that the REMI default employment forecast differs from SCAG's projections by industry sector, and significantly so for a number of sectors such as telecommunications and apparel manufacturing sectors. The adjusted REMI baseline forecast of employment more closely reflects the SCAG-projected rates of growth for most sectors.

Table 4A-1: Average Annual Employment Growth Rates by County, 2016-2031

County	Default REMI	SCAG	Adjusted REMI
Los Angeles	0.0%	0.7%	0.7%
Orange	0.1%	0.8%	0.8%
Riverside	0.3%	2.0%	2.0%
San Bernardino	0.1%	1.3%	1.5%
Four-county region	**0.1%**	**0.9%**	**1.0%**

Table 4A-2: Average Annual Employment Growth Rates by Industry for the Four-County Region, 2016-2031

Industry	Default REMI	SCAG	Adjusted REMI
Utilities	-2.1%	0.9%	0.8%
Construction	1.8%	1.9%	1.9%
Wholesale trade	-0.4%	0.9%	0.8%
Professional, scientific, and technical services	0.9%	1.1%	1.1%
Management of companies and enterprises	-1.2%	1.0%	1.0%
Educational services	0.2%	1.0%	1.0%
Agriculture and forestry support activities	-0.9%	0.2%	0.0%
Oil and gas extraction	0.7%	0.0%	0.0%
Mining (except oil and gas)	0.2%	0.0%	0.0%
Support activities for mining	1.5%	0.0%	-0.1%
Food manufacturing	-0.6%	0.1%	0.1%
Beverage and tobacco product manufacturing	-0.4%	0.1%	0.4%
Wood product manufacturing	0.3%	0.1%	0.1%
Paper manufacturing	-1.6%	-0.2%	-0.4%
Printing and related support activities	-1.7%	0.1%	0.1%
Petroleum and coal products manufacturing	-1.2%	-0.1%	-0.3%
Chemical manufacturing	-1.9%	-0.3%	-0.1%
Plastics and rubber product manufacturing	-1.9%	-0.2%	-0.3%
Nonmetallic mineral product manufacturing	0.8%	0.1%	0.0%
Primary metal manufacturing	-2.4%	-0.1%	0.1%
Fabricated metal product manufacturing	-0.5%	-0.2%	-0.2%
Machinery manufacturing	-2.1%	-0.1%	-0.2%
Computer and electronic product manufacturing	-1.2%	-0.3%	-0.3%
Electrical equipment and appliance manufacturing	-2.4%	-0.3%	-0.3%
Furniture and related product manufacturing	-0.4%	0.1%	0.0%
Miscellaneous manufacturing	-2.5%	-0.1%	-0.1%
Air transportation	-2.7%	0.2%	0.3%
Rail transportation	-1.4%	0.9%	1.7%
Water transportation	0.5%	0.4%	0.8%

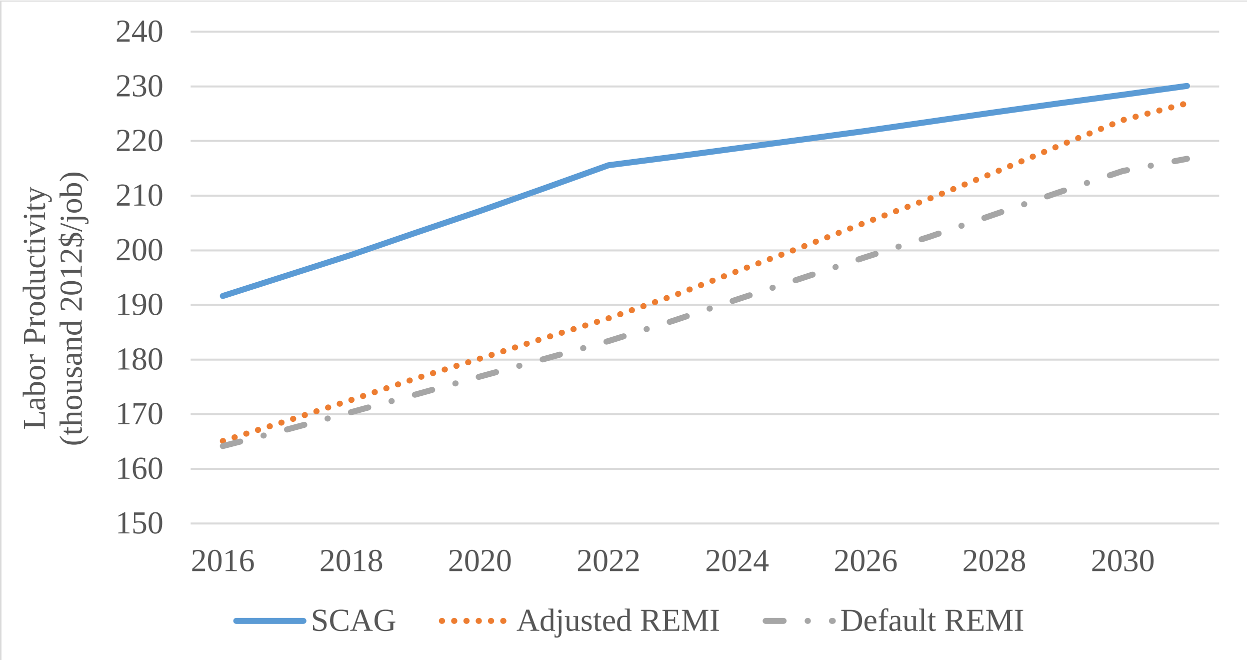
Industry	**Default REMI**	**SCAG**	**Adjusted REMI**
Truck transportation	-0.4%	0.7%	0.7%
Transit and ground passenger transportation	0.0%	0.7%	0.6%
Pipeline transportation	-2.9%	0.7%	0.4%
Couriers and messengers	-2.3%	0.7%	0.9%
Warehousing and storage	0.4%	0.8%	1.5%
Publishing industries, except Internet	-0.8%	0.8%	0.7%
Motion picture and sound recording industries	-1.0%	0.5%	0.3%
Broadcasting, except Internet	-0.8%	0.4%	0.2%
Telecommunications	-2.3%	1.0%	1.2%
Securities, commodity contracts, investments	-0.1%	0.8%	0.7%
Insurance carriers and related activities	0.0%	0.6%	0.7%
Real estate	0.0%	0.6%	0.8%
Administrative and support services	0.6%	1.3%	1.3%
Waste management and remediation services	0.0%	1.6%	1.5%
Ambulatory health care services	1.1%	1.5%	1.5%
Hospitals	1.2%	0.9%	0.9%
Nursing and residential care facilities	0.7%	1.2%	1.1%
Social assistance	1.0%	1.6%	1.5%
Performing arts and spectator sports	-0.6%	0.6%	0.5%
Museums, historical sites, zoos, and parks	0.8%	0.8%	0.7%
Amusement, gambling, and recreation	0.2%	0.8%	1.3%
Accommodation	0.2%	0.7%	0.7%
Food services and drinking places	-0.1%	0.7%	0.7%
Repair and maintenance	-0.6%	1.1%	1.1%
Personal and laundry services	-0.6%	0.9%	0.9%
Membership associations and organizations	-0.3%	0.8%	0.9%
Forestry and logging; Fishing, hunting, and trapping	-0.8%	0.3%	-1.4%
Textile mills; Textile product mills	-2.8%	-0.1%	0.0%
Apparel manufacturing; Leather and allied product manufacturing	-4.1%	-0.1%	-0.1%
Motor vehicles, bodies and trailers, and parts manufacturing	-0.6%	0.2%	-0.1%
Other transportation equipment manufacturing	-1.7%	-0.4%	0.0%
Retail trade	-0.4%	0.9%	-0.6%
Scenic and sightseeing transportation; Support activities for transportation	0.1%	0.4%	0.8%
Internet publishing and broadcasting; ISPs, search portals, and data processing; Other information services	-1.6%	0.7%	0.2%
Monetary authorities - central bank; Credit intermediation and related activities; Funds, trusts, & other financial vehicles	-0.9%	0.7%	0.7%
Rental and leasing services; Lessors of nonfinancial intangible assets	0.4%	1.0%	1.1%

Updating the employment forecast in REMI not only changes the levels of employment, it may also change the output and the labor productivity (measured in $/job), the latter of which is a major parameter that affects a policy's job impact modeled in REMI. The labor productivity is determined according to the simplified production function below:[4]

$$Y = LP * E, \qquad (1)$$

where *Y* is output in dollars, *LP* is the labor productivity, and *E* is the employment level. According to REMI technical staff, the Employment Update function changes *E* from its REMI defaults to an adjusted *E'* for every time period so that the period-to-period change in *E'* would reflect SCAG's growth rate, and an algorithm concurrently changes *Y*. The percent change in *Y* is less than the percent change in *E* for some industries and more for others. Therefore, the labor productivity may increase or decrease from the default values in REMI as a result of this employment update. Any difference in labor productivity as a result of this employment update is shown in Figure 4A-4. It can be seen that the difference is the largest in years further into the future. SCAQMD staff empirically tested the correlation between employment and output changes for year 2031 and found that, on average, the ratio of the percentage change in output and percentage change in employment was approximately one, which indicated that, on average, the labor productivity remained close to the REMI defaults and the divergence in labor productivity in later years was driven mainly by a few outliers. The by-sector percentage changes in labor productivity from default REMI to adjusted REMI in 2031 are shown in Table 4A-3.

Figure 4A-4: Labor Productivity, 2016-2031 for the Four-County region



[4] This is the inverse of a simplified version of equation 2-5 from PI+ v1.7 Model Equations (REMI 2015c).

Table 4A-1: Changes in Labor Productivity from Default REMI to Adjusted REMI in 2031 by Industry for the Four-County Region

Industry	% Change	Direction
Monetary authorities – central bank; Credit intermediation and related activities; Funds, trusts, & other financial vehicles	6.3%	(+)
Amusement, gambling, and recreation	5.5%	(+)
Nonmetallic mineral product manufacturing	5.0%	(-)
Pipeline transportation	4.4%	(-)
Publishing industries, except Internet	3.6%	(-)
Mining (except oil and gas)	3.3%	(-)
Forestry and logging; Fishing, hunting, and trapping	2.3%	(-)
Beverage and tobacco product manufacturing	1.9%	(-)
Telecommunications	1.6%	(+)
Fabricated metal product manufacturing	1.4%	(-)
Food manufacturing	1.4%	(-)
Warehousing and storage	1.3%	(+)
Utilities	1.2%	(-)
Primary metal manufacturing	1.2%	(-)
Petroleum and coal products manufacturing	1.2%	(-)
Rail transportation	1.1%	(-)
Motor vehicles, bodies and trailers, and parts manufacturing	1.1%	(-)
Chemical manufacturing	1.1%	(-)
Performing arts and spectator sports	1.0%	(-)
Repair and maintenance	1.0%	(-)
Personal and laundry services	1.0%	(-)
Transit and ground passenger transportation	0.9%	(-)
Paper manufacturing	0.8%	(-)
Air transportation	0.8%	(-)
Scenic and sightseeing transportation; Support activities for transportation	0.8%	(-)
Miscellaneous manufacturing	0.8%	(-)
Motion picture and sound recording industries	0.7%	(-)
Waste management and remediation services	0.7%	(-)
Machinery manufacturing	0.6%	(-)
Furniture and related product manufacturing	0.6%	(-)
Insurance carriers and related activities	0.6%	(-)
Rental and leasing services; Lessors of nonfinancial intangible assets	0.6%	(+)
Real estate	0.6%	(+)
Textile mills; Textile product mills	0.6%	(-)
Accommodation	0.6%	(-)
Truck transportation	0.6%	(-)
Wholesale trade	0.5%	(-)
Plastics and rubber product manufacturing	0.5%	(-)
Wood product manufacturing	0.5%	(-)
Printing and related support activities	0.5%	(-)
Oil and gas extraction	0.5%	(-)

Industry	% Change	Direction
Retail trade	0.4%	(-)
Computer and electronic product manufacturing	0.4%	(-)
Electrical equipment and appliance manufacturing	0.4%	(-)
Couriers and messengers	0.4%	(-)
Social assistance	0.4%	(-)
Apparel manufacturing; Leather and allied product manufacturing	0.4%	(-)
Other transportation equipment manufacturing	0.3%	(-)
Ambulatory health care services	0.3%	(+)
Agriculture and forestry support activities	0.3%	(-)
Museums, historical sites, zoos, and parks	0.3%	(-)
Broadcasting, except Internet	0.3%	(-)
Membership associations and organizations	0.3%	(-)
Internet publishing and broadcasting; ISPs, search portals, and data processing; Other information services	0.2%	(-)
Water transportation	0.2%	(-)
Administrative and support services	0.2%	(+)
Support activities for mining	0.2%	(+)
Educational services	0.2%	(-)
Nursing and residential care facilities	0.2%	(-)
Professional, scientific, and technical services	0.1%	(+)
Food services and drinking places	0.1%	(+)
Hospitals	0.1%	(-)
Construction	0.0%	(+)
Securities, commodity contracts, investments	0.0%	(-)
Private households	0.0%	(-)
Management of companies and enterprises	0.0%	(-)

It is important to note that, in Figure 4A-4, the labor productivity shown as the "Adjusted REMI", while on average is close in value to "Default REMI," is generally lower than the labor productivity that SCAG uses to generate forecasted output for the purpose of the 2016 AQMP baseline emission inventory. REMI does not provide a function that allows users to update both employment and labor productivity. Even if such function exists, however, the labor productivities used by SCAG may not be directly used to replace REMI labor productivities. This is because labor productivity is calculated as output per job, and as discussed above (Equation 1), SCAG and REMI differ greatly in their employment definitions, which result in large differences in the numerator of labor productivity calculation.

One of the important implications of the changes in the modeled labor productivity is that it affects the magnitude of employment impacts that will be simulated by the REMI model. To understand this by examining direct employment effects,[5] we can rewrite $Y = LP * E$ as:

$$E = EPV * Y, \qquad (2)$$

[5] There are also indirect and induced effects.

where $EPV = LP^{-1}$ is jobs per dollar of output. Totally differentiating the equation above, we obtain:

$$dE = EPV * dY. \quad (3)$$

Therefore, for some change in output, $dY \neq 0$, and some $EPV' > EPV$, then $|dE'| > |dE|$. In other words, a policy that directly or indirectly changes output will have an amplified employment impact with a greater EPV (lower LP) and dampened one with a lower EPV (greater LP).

Therefore, when the REMI model with the adjusted baseline results in a lower labor productivity, employment impacts will be greater than those that would be predicted by the REMI model with the default baseline. However, differentials in job impacts are minimal for most of the sectors, as labor productivity by sector is mostly very similar between the adjusted and the default REMI baselines. As an example, using the different estimates of labor productivity for the sector of apparel manufacturing and leather and allied products manufacturing in 2031, a policy that causes a $10 million decrease in output, would result in a *direct* employment effect of 47 predicted jobs foregone using labor productivity values in either adjusted or default REMI baselines.[6]

Population Baseline Adjustment

Data

The default population forecast embedded in the REMI model is based on the demographic assumptions used in the U.S. Census Bureau's national population projections and refined with region-specific parameters, including birth, death, and international migration rates.[7] In comparison, SCAG's sub-county population forecast is based on the projections developed for its 2016 Final RTP/SCS at the TAZ level. SCAG projections considered various data sources, including those published by the U.S. Census Bureau and the California Department of Finance, and refined with local inputs (SCAG 2016). The TAZ-level population projections by gender, race/ethnicity, and age cohort are then aggregated to the 21 sub-county regions and transmitted to the SCAQMD, specifically for the use in the REMI sub-county model which was customized for the South Coast 4-county region (REMI PI$^+$ v1.7.3).

Method

SCAG staff provided sub-county sub-population projections for 11 years between 2016 and 2031, in addition to the 2012 base year. For years that are missing from the provided forecast, linear interpolation was used to estimate population for these in-between years. The 2014-2031 data were transposed and entered into REMI using its Population Update function, concurrently with the

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[6] Based on labor productivities of $0.220, and $0.221 million/job, respectively. This example is based on fixed input-output relationship, which does not take into account indirect effects. As this industry's intermediate demands change, the employment effects of these changes could widen, albeit how slightly, the difference in job impact across and the adjusted and the default REMI baselines.

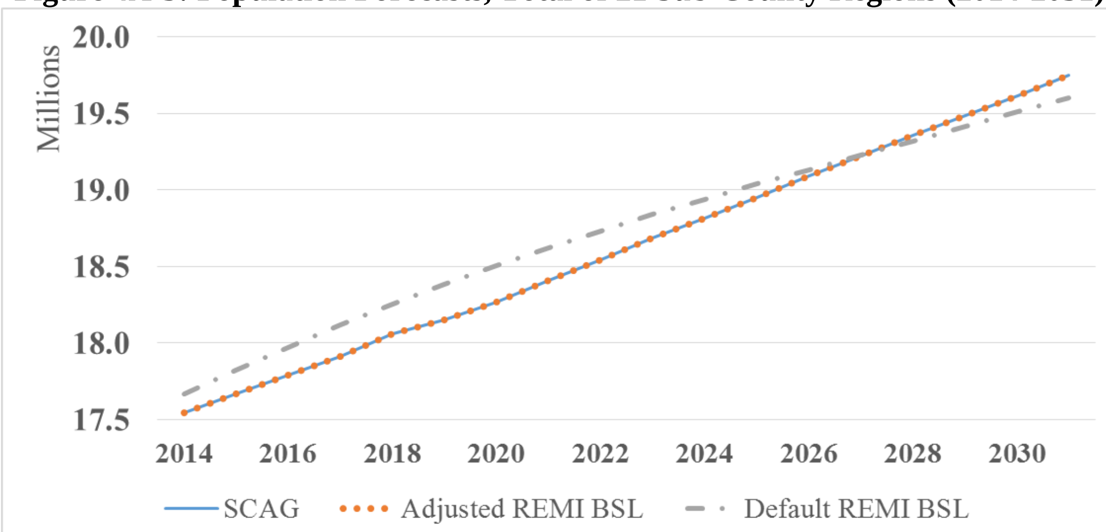
[7] REMI documentation "REMI PI$^+$ v1.7: Demographic Component of the REMI Model" (2015b) and in consultation with REMI technical staff.

Employment Update described above, to generate an alternative baseline scenario, or "Regional Control," that reflected SCAG's projections. The 2014-2031 data were used because the Population Update function allows users to adjust population for the forecast years only, and the last historical year in REMI PI$^+$ v1.7.3 is 2013.[8]

Results and Implications

It can be seen from Figure 4A-5 that the adjusted REMI baseline perfectly aligns with the projected total population using SCAG's projections for the 21 sub-county regions. An examination of the discrepancies among all sub-county, sub-population groups showed infinitesimal differences for all years.

Figure 4A-5: Population Forecasts, Total of 21 Sub-County Regions (2014-2031)



It should be noted that no adjustments of birth rates by age cohort was done prior to entering data into the Population Update. Such adjustments were recommended back in 1994 (Levy 1994) and implemented for earlier AQMPs, largely due to the lack of detailed sub-population data table as needed to populate the REMI forecast. Therefore, cohort birth rates were used to generate the needed table. This is now obviated as SCAG provides the necessary sub-population forecast data to fill the Population Update table in REMI. The birth rates in the adjusted REMI baseline are different than the REMI default rates. This is a result of the Population Update *per se* and may not reflect entirely the birth rates assumed by the SCAG demographic projections.

According to REMI technical staff, the REMI Population Update function treats the initial difference in 2014 between the adjusted and default REMI baselines as a decrease in the number of international migrants. Then, if the implied next-period population by the embedded

[8] As REMI solves its model per time period, simulation results for years 2014-2031 will not be affected by maintaining the default REMI baseline for the historical and post-2031 years. (This is in contrast to an intertemporal forward-looking model.)

demographic assumptions does not match up with that projected by SCAG, any remaining differences are again attributed to international migration. The process continues for all subsequent periods until 2031. Because economic behaviors do not differ by migrant status in the REMI model, this update procedure is not expected to cause any changes in key parameter values that could influence simulation results, other than a different baseline population to compare to.

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