

**Environmental Justice Analysis of Minority and Low-Income Populations  
Adjacent to Goods Movement Corridors in Southern California**

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**1 ABSTRACT**

2 Southern California is the largest international trade gateway in the U.S., and the region also generates  
3 enormous local and domestic goods movement activity. Given the expected growth in international trade  
4 and domestic goods movement in the future, significant growth in truck volumes and rail traffic are  
5 anticipated in the region to facilitate reliable goods movement and to support economic growth. As goods  
6 movement is a major contributor to local and regional environmental issues, such as air pollution and  
7 health risk, it is a regional priority not only to mitigate the environmental impacts of the goods movement  
8 system, but also to ensure that there is equity in distribution of environmental benefits and burdens from  
9 federally funded goods movement programs and projects pursuant to Title VI of the Civil Rights Act.

10 Therefore, in order to prevent disproportionately high and adverse environmental effects and  
11 health risks on minority and low-income populations from the goods movement system, the Southern  
12 California Association of Governments conducted Environmental Justice analyses for the goods  
13 movement system included in the Regional Transportation Plan. The objective of this paper is to identify  
14 minority and low-income populations, to analyze their spatial distributions along major truck corridors  
15 and freight rail corridors, and to address the Environmental Justice implications of the goods movement  
16 system in Southern California.

## 17 INTRODUCTION

18 The Southern California Association of Governments (SCAG) is the designated metropolitan planning  
19 organization (MPO) under federal law, responsible for developing and adopting a long-range Regional  
20 Transportation Plan (RTP) every four years which serves as a basis for transportation decision-making in  
21 the region (SCAG Region). As a federally funded government agency, SCAG is responsible for  
22 implementing Title VI of the Civil Right Act of 1964, which states that “no person in the United States  
23 shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the  
24 benefits of, or be subjected to discrimination under any program or activity receiving Federal financial  
25 assistance.” And, by Executive Order 12898 from 1994, Title VI was further amplified by providing that  
26 “each Federal agency shall make achieving environmental justice part of its mission by identifying and  
27 addressing, as appropriate, disproportionately high and adverse human health or environmental effects of  
28 its programs, policies, and activities on minority populations and low-income populations.” And, Orders  
29 on Environment Justice by U.S. Department of Transportation (DOT) in 1997 and Federal Highway  
30 Administration (FHWA) in 1998 which were issued in support of Executive Order 12898 (1). SCAG is  
31 determined and committed to developing long range plans that will improve, correct or mitigate any  
32 disproportionate impacts to our Environmental Justice Population Groups.

33 In compliance with federal and state requirements and guidelines on Environmental Justice,  
34 SCAG has been integrating the principles of Title VI to address Environmental Justice in preparation for  
35 its RTPs. On April 4, 2012, SCAG adopted the 2012-2035 Regional Transportation Plan/Sustainable  
36 Communities Strategy (2012-2035 RTP/SCS) containing a regional commitment to reduce emissions  
37 from transportation sources pursuant to Senate Bill (SB) 375 through which the California Air Resources  
38 Board (CARB) set per capita targets for reduction in greenhouse gas (GHG) emissions—8 percent in  
39 2020 and 13 percent in 2035 from 2005 levels. In preparation for the 2012-2035 RTP/SCS, SCAG  
40 conducted Environmental Justice analyses to assess the impacts of programs and projects included in the  
41 2012-2035 RTP/SCS on minority and low-income populations (herein called “Environmental Justice  
42 population groups”).

43 Amongst transportation programs and projects of the 2012-2035 RTP/SCS, one of the key  
44 strategies is the development of a freight transportation system to maintain economic growth in the  
45 region, to sustain quality of life and to meet federal air quality requirements (2). The goods movement  
46 system in Southern California consists of two major user markets—domestic/regional/local trade and  
47 international trade. The SCAG Region is the largest international trade gateway in the U.S. The Ports of  
48 Los Angeles and Long Beach, rank first and second largest among container port facilities in the U.S.,  
49 respectively, and together they rank as third largest container port complex in the world (3). The Ports of  
50 Los Angeles and Long Beach together shared over 31 percent of total container volume in the U.S. in  
51 2009; and, it is forecasted that the total container volumes for the ports will gain market share rising to 37  
52 percent of total U.S. volume by 2030 (3). While the region is a major international gateway, a dominant  
53 goods movement activity generated in the SCAG Region is the local, regional and domestic trade system.  
54 The intra-regional goods movement forms more than 85 percent of truck trips (2). The rail system  
55 supports domestic goods movement by providing a critical connection between the nation’s largest port  
56 complex and the rest of the nation. In 2010, goods movement-dependent industries, such as  
57 manufacturing, wholesale, retail sales, construction and warehousing, contributed \$253 billion to the  
58 regional gross domestic product (GDP) (2). Given the economic growth of the SCAG Region and the  
59 recovery and expansion of international trade in the national economy, it is imperative that regional goods  
60 movement infrastructure continue to serve market demand and to facilitate the enormous economic  
61 growth in the region.

62 As truck and rail volumes are expected to continue to increase, it is critical to develop strategies  
63 to relieve increasing environmental concerns in the SCAG Region as well as improving regional goods  
64 movement infrastructure to accommodate economic and transportation growth. Heavy-duty trucks and  
65 freight rail are usually powered by diesel fuel and they are major sources of NO<sub>x</sub>, and PM<sub>2.5</sub> emissions,  
66 which contribute to community health risks, including respiratory illnesses and asthma. The goods  
67 movement system is also a major source of CO<sub>2</sub> emissions, the most significant GHG which causes global

68 climate change. Therefore, it is essential to reduce the impacts of the regional goods movement system on  
69 the environment and public health as well as to improve its infrastructure. In order to achieve this goal,  
70 the 2012-2035 RTP/SCS includes strategies to address community health concerns and environmental  
71 issues while facilitating technology development that contributes to economic growth. The concerns  
72 expressed through public outreach to the communities is that the projects included in SCAG's long range  
73 plan not be primarily located in low income areas or areas with high concentration of minority or foreign  
74 born population. To address these concerns, SCAG has developed strategies which include a near term  
75 approach supporting the deployment of commercially available lower-emission freight system and the  
76 long term approach implementing zero- and near-zero emission freight system (2). Air quality in the  
77 SCAG Region is expected to improve significantly due to reductions in emissions in the future given the  
78 implementation of the strategies recommended in the 2012-2035 RTP/SCS.

79 However, there are areas with concentration of minority and low-income populations (herein  
80 called "Environmental Justice areas") where the SCAG Region needs to improve in terms of the potential  
81 disproportionately high and adverse human health or environmental effects on Environmental Justice  
82 population groups. For example, it was observed that the distributional impact of PM<sub>2.5</sub> in the  
83 Environmental Justice areas exceeds the regional average (2). In this regards, SCAG analyzed the impacts  
84 of programs and projects of the 2012-2035 RTP/SCS on Environmental Justice population groups. As a  
85 part of SCAG's Environmental Justice analyses, this paper focuses on identifying the Environmental  
86 Justice population groups, examining spatial distributions of each group along major truck and freight rail  
87 corridors, estimating emission intensity along major truck corridors, and discussing the Environmental  
88 Justice concerns and issues from the goods movement system in the SCAG Region.

89

#### 90 **Literature Review: Environmental Impacts of Goods Movement System on Nearby Communities**

91 Several studies have already evaluated the environmental impacts of the goods movement system,  
92 especially diesel trucks and freight rail activities, on nearby communities. Some studies analyzed the  
93 environmental impacts of heavy-duty diesel truck operations on near-roadway communities and its  
94 environmental justice implications (4, 5, 6). The studies discussed Environmental Justice concerns about  
95 the concentration of heavy-duty truck-related environmental impacts on minority and low-income  
96 communities adjacent to freight truck corridors, such as cancer risk, air pollution, noise, traffic safety and  
97 congestion issues. Other studies examined the impact of truck and rail freight movement on air quality  
98 and GHG emissions. Though freight rail impacts accounts for only a small portion of goods movement  
99 emissions, the studies indicated that the concentration of environmental impacts along the freight rail  
100 facilities raises local-level Environmental Justice questions (7, 8). These local level Environmental  
101 Justice questions reflect a need to develop strategies to improve the transportation system while not  
102 building projects or developing strategies that adversely affect minority and low-income communities.  
103 The studies also expected that PM and NO<sub>x</sub> emissions contributions from freight rail movement will be  
104 growing significantly in the future, raising concerns about equity in the distribution of benefits of and  
105 burdens from freight rail operations (7, 8).

106

#### 107 **METHODOLOGY**

108 The approach for the spatial distribution analysis of Environmental Justice population groups consists of  
109 three steps. First, the Environmental Justice population groups were identified according to Executive  
110 Order 12898 and the Orders on Environmental Justice by DOT and FHWA. Second, an appropriate  
111 criteria for buffer distance from major truck and freight rail corridors was determined, based on guidance  
112 and recommendations from various organizations. Third, using the selected distance criteria, the spatial  
113 analysis of Environmental Justice population groups was conducted by using an area-weighted  
114 interpolation method. As discussed earlier, though the contribution of freight rail emissions are not  
115 significant in the SCAG Region—5 percent and 4 percent of regional goods movement related to NO<sub>x</sub>  
116 and PM emissions, respectively (2), concentrations of emissions from rail activities can cause localized  
117 concentrations, especially given the expected growth in goods movement. In this regard, this research  
118 performed analyses of socioeconomic indicator distributions from major truck and freight rail corridors,

119 separately. In addition to distribution analysis of Environmental Justice population groups, this paper  
120 compared the projected growth changes of Environmental Justice population groups between areas  
121 adjacent to major truck corridors and areas adjacent to freight rail corridors to examine socioeconomic  
122 characteristics of each area. Also, this paper conducted a comparative analysis of emission intensity  
123 between areas in proximity to major truck corridors and freeways in the SCAG Region to understand the  
124 environmental impacts from freight truck operations on the Environmental Justice population groups  
125 living in proximity to major truck corridors.

126

### 127 **Identifying Environmental Justice Population Groups**

128 To assess the issue of potential disproportionate distribution of environmental impacts on Environmental  
129 Justice population groups from goods movement system, it is necessary to identify minority and low-  
130 income populations. Executive Order 12898 and the Orders on Environmental Justice by DOT and  
131 FHWA define “minority” as a person who is Black, Hispanic or Latino, Asian American, American  
132 Indian, Alaskan Native, Native Hawaiian and Other Pacific Islander. SCAG analyzed the ethnic/racial  
133 groups by transportation analysis zones (TAZ) (11,000+ zones equivalent to census block groups), based  
134 on the SCAG’s growth forecast.

135

#### 136 *SCAG’s Growth Forecast Development*

137 The SCAG’s growth forecast for different levels of geography is developed using the top-down approach  
138 with a strong emphasis of local input process. The following is a summary of how SCAG developed TAZ  
139 population and household forecasts with additional socioeconomic attributes (9).

140 SCAG projects region/county population and households using the cohort-component model and  
141 the headship rate method. The model computes population at a future point in time by adding to the  
142 existing population the number of group quarters population, births, and persons moving into the region  
143 during a projection period, and by subtracting the number of deaths and the number of persons moving  
144 out of the region. The projected households at a future point in time are computed by multiplying the  
145 projected residential population by projected headship rates. Headship rate is the proportion of a  
146 population cohort that forms the household. Age-gender-racial/ethnic specific household formation level  
147 is applied to the projected population to estimate households. Demographic and economic assumptions  
148 play a decisive role in determining the size of population in the future. Population size is projected by  
149 identifying the demographic rates (e.g., fertility rate, survival rate, migration rate) of the population  
150 cohort. Household formation behavior reflecting the assimilation pattern determines the future households.

151 The city population and household forecast is initially derived by multiplying the 2008 RTP  
152 jurisdiction’s share of the county growth delta during the forecast horizon by the updated county  
153 household growth delta during the same period. The jurisdiction’s relative growth pattern in the 2008  
154 RTP growth forecast remained constant. The jurisdictional level household size and the group quarters  
155 population from the recent estimates of California Department of Finance are incorporated into the new  
156 database. TAZ population and household forecasts are derived using the housing unit (HU) method, as  
157 used in the city forecasts. The first step of the housing unit method is to project housing units at the TAZ  
158 level. Since SCAG focuses on the household forecast, SCAG derives the initial TAZ household forecasts  
159 by reflecting growth patterns incorporated in the 2008 RTP forecasts, recent estimates and trends, and  
160 updated city household forecasts. The TAZ household forecast is converted into population by using the  
161 group quarters population plus the product of households and average persons per household (PPH). The  
162 average number of persons per household is projected using the recent estimates and trends, and is  
163 constrained by the updated city PPH. Group quarters population is projected using the TAZ’s share of the  
164 city population from the 2000 Census and 2008 DOF, which is assumed to remain constant during the  
165 projection horizon. Local input plays an important role in developing an accurate growth forecast for  
166 2012–2035 RTP/SCS. Although the local input is an on-going process, SCAG updated the preliminary  
167 population and household forecasts using local input from local jurisdictions for at least three times  
168 during the development of the growth forecast.

169 Population and household forecasts are further disaggregated into necessary socioeconomic  
 170 attributes (e.g., age, race/ethnicity, income quintiles, etc.), as required in the environmental justice  
 171 analysis. The additional attribute variables are called secondary variables. These secondary variables at  
 172 the TAZ level are estimated using the Small Area Secondary Variables Allocation Model (SASVAM)  
 173 (10). SASVAM generally relies on the probabilistic choice model, which reflects the temporal change of  
 174 the socioeconomic attributes of TAZs. The SASVAM results are controlled to the county level forecasts  
 175 including the results of the cohort-component model, the trend extrapolation, or the statistical method. For  
 176 example, TAZ household forecasts by race/ethnicity are derived by using SASVAM and controlled for  
 177 the county household forecasts by race and ethnicity (11). The household forecasts by race and ethnicity  
 178 is further disaggregated into quintiles of household income. The iterative proportional fitting method is  
 179 used to update income quintiles consistent with the TAZ household forecasts by race/ethnicity.  
 180

#### 181 *Social Demographic Indicators for Environmental Justice Population Groups*

182 Social demographic indicators were selected based on the Environmental Justice Strategic Enforcement  
 183 Assessment Tool (EJSEAT), a tool for the EPA Office of Enforcement and Compliance Assurance  
 184 (OECA) to identify areas with potentially disproportionately high and adverse environmental and public  
 185 health burdens (12). Also, ‘low-income’ population was defined as a person whose median household  
 186 income is at or below the Department of Health and Human Services (HHS) poverty guidelines. The  
 187 poverty threshold for the SCAG Region is based on regional average household size for the census year;  
 188 for example, for a regional mean of 2.98 persons (rounded to 3) per household, the threshold would  
 189 consist of the sum of the value for the first person plus two additional people (2). The household counts in  
 190 each income range are then used to determine the number and percentage of households in each census  
 191 tract below the poverty level which is a family of three earning less than \$17,374 in 2010 (13). In  
 192 addition, SCAG analyzed income quintile and the ethnic distribution within each income quintile by  
 193 processing the 2005-09 ACS data. The following is the list of the socioeconomic indicators SCAG used  
 194 as a reference population group in the Environmental Justice analyses and also the list of regional income  
 195 quintiles based on the household income data:  
 196

#### 197 Ethnic/Racial/Other Indicators:

- 198 • White (Non-Hispanic), Hispanic (Latino), African-American, American Indian, Asian/Pacific
- 199 Islander, Other Racial Categories
- 200 • Disabled/Mobility Limited, Age 65 and Above, Age 5 and Below

#### 201 Income Indicators:

- 202 • Below Poverty Level
- 203 • Income Quintile 1 (\$0 to \$24,581), Income Quintile 2 (\$24,582 to \$46,436), Income Quintile
- 204 3 (\$46,437 to \$73,554), Income Quintile 4 (\$73,555 to \$99,999), Income Quintile 5 (\$100,000 and
- 205 Higher)
- 206

207 The EPA Environmental Justice guidance (the Guidance) explains that minority population is  
 208 concentrated if the percentage of the minority population and the low-income population of the affected  
 209 area is “meaningfully greater” than the percentage of the minority population and low-income population  
 210 in the general population of the region (14). In order to assess the concentration of the Environmental  
 211 Justice population groups, a comparative analysis was conducted on the percentage of the Environmental  
 212 Justice population groups between areas adjacent to the goods movement system, including major truck  
 213 and freight rail corridors, and the regional average.  
 214

#### 215 **Determining Distance Criteria for Freight Transportation System**

216 To assess the distribution of the Environmental Justice population groups along major truck and freight  
 217 rail corridors, it is necessary to consider appropriate distance criteria for the environmental impacts  
 218 extent. In order to determine suitable distance criteria, SCAG referred to guidance and recommendations

219 from various organizations, such as the California Air Resources Board (CARB) and Southern California  
220 Air Quality Management District (SCAQMD). CARB recommends avoiding siting new sensitive land  
221 uses within 500 feet (150 meters) between a freeway and high-traffic roads in its Air Quality and Land  
222 Use Handbook (the Handbook). The Handbook also recommends avoiding sensitive land uses within  
223 1,000 feet (300 meters) of busy distribution centers and major service and maintenance rail yards (15).  
224 SCAQMD's Health Risk Assessment Guidance establishes a minimum buffer of 1,000 feet between truck  
225 traffic and sensitive receptor locations to reduce exposure from idling (16). In addition, a California  
226 Office of Environmental Health Hazard Assessment (OEHHA)'s study found that places within 500 feet  
227 of main city streets, highways, and freeways generally have higher traffic pollutant levels (17). Based on  
228 the guidance and recommendations, SCAG used 500 foot and 1,000 foot buffers to test if there is a  
229 statistical difference between two buffers in assessing the spatial distribution of the Environmental Justice  
230 population groups. The test showed there is no significant difference in terms of the Environmental  
231 Justice population group distribution between the two buffers. In this regards, SCAG used 500 foot buffer  
232 only to assess the spatial distribution of the Environmental Justice population groups for this research.

233

### 234 **Spatial Analysis of Distribution of Environmental Justice Population Groups**

235 To analyze the spatial distribution of Environmental Justice population groups, a residential area-  
236 weighted interpolation method was used. The residential area-weighted interpolation method assumes that  
237 the population is distributed equally within residential areas of a TAZ, and it calculates population based  
238 on the area ratio of the residential areas of a TAZ interested with 500 foot buffer to the entire residential  
239 areas of a TAZ. For example, if a TAZ has 1,000 non-Hispanic Asian population and 25% of total  
240 residential area of the TAZ is intersected with 500 feet buffer from major truck corridors, then it is  
241 estimated that 250 out of the TAZ's total non-Hispanic Asian population reside within 500 feet from  
242 major truck corridors. To evaluate the spatial concentration of Environmental Justice population groups  
243 along major truck and freight rail corridors, the percentage of each socioeconomic indicator within 500  
244 foot buffer were estimated and then compared with the regional average.

245

### 246 **Estimation of Emission Intensity along Major Truck Corridors**

247 In addition, air pollutant emission intensity analysis was conducted for communities in proximity to major  
248 truck corridors to assess environmental impacts of freight truck operations on the Environmental Justice  
249 population groups living in proximity to major truck corridors. Emission intensity analysis is based on  
250 running emission estimates from SCAG's emission impact study for air pollutants, including reactive  
251 organic gases (ROG), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), sulfur  
252 dioxide (SO<sub>2</sub>), particulate matter (PM<sub>2.5</sub>) (2). Emissions were estimated for the year 2008 at the TAZ  
253 level. To estimate emission intensity, TAZs located within 500 feet from major truck corridors were  
254 selected, and total emissions of each emission factor were estimated by aggregating emissions within the  
255 selected TAZs. Then, the total emissions were normalized by total acreage of the selected TAZs. To  
256 compare the emission intensity of TAZs along major truck corridors with the regional level, the same  
257 methodology was used to estimate emission intensity of TAZs along freeways in the SCAG Region. The  
258 emission data used in the research includes emissions from both passenger car and truck movement. In  
259 this vein, to better assess the impacts of freight movement separately from passenger cars, SCAG  
260 estimated the vehicle-miles traveled (VMT) for truck movement on the major truck corridors, and then,  
261 compared it with the truck VMT for the rest of freeways in the SCAG Region.

262

## 263 **ANALYSIS RESULTS**

264

### 265 **Distribution of Environmental Justice Population Groups along Major Truck and Freight Rail 266 Corridors**

267 Table 1 presents the socioeconomic indicators within 500 feet from major truck and freight rail corridors  
268 in 2008 and 2035. As shown in the table, the share of most Environmental Justice population groups  
269 living in proximity to major truck and freight rail corridors is higher than regional average both in 2008

270 and 2035. The table also presents the share of five income quintile households and the ethnic distribution  
 271 within each income quintile within TAZs in proximity to major truck and freight rail corridors. It was  
 272 observed that the share of lower income quintile households and minority populations is higher in TAZs  
 273 in proximity to major truck corridors than the regional average. These observations imply that truck and  
 274 rail-related environmental burdens could be higher for the minority and low-income communities than the  
 275 regional average. However, further analysis is needed to verify this observation.  
 276

277 **TABLE 1 Distribution of Environmental Justice Population Groups in TAZs Adjacent to Major**  
 278 **Truck and Freight Rail Corridors: 2008 and 2035**

	500 Feet from Major Truck Corridors				500 Feet from Freight Railroads				SCAG Region	
	2008		2035		2008		2035		2008	2035
Population	332,436		408,538		192,668		255,344			
Households	100,247		125,804		57,794		77,686			
Hispanic	186,675	56.2%	264,668	64.8%	107,969	56.0%	169,294	66.3%	44.8%	55.4%
NH White	77,135	23.2%	63,198	15.5%	55,537	28.8%	46,952	18.4%	34.4%	23.5%
NH Black	24,150	7.3%	25,902	6.3%	6,589	3.4%	9,729	3.8%	6.9%	6.1%
NH NA	1,620	0.5%	2,123	0.5%	1,113	0.6%	1,590	0.6%	0.4%	0.5%
NH Asian	37,323	11.2%	45,508	11.1%	18,347	9.5%	23,507	9.2%	11.6%	12.3%
NH Others	5,533	1.7%	7,138	1.7%	3,113	1.6%	4,273	1.7%	1.9%	2.1%
Age 65 & Above	30,433	9.2%	61,625	15.1%	17,301	9.0%	37,936	14.9%	10.4%	16.7%
Age 5 & Below	31,305	9.4%	36,165	8.9%	18,390	9.5%	22,684	8.9%	8.7%	8.2%
Disabled	30,702	9.2%	40,839	10.0%	16,445	8.5%	23,593	9.2%	8.6%	9.3%
Poverty 1*	15,708	15.7%	19,778	15.7%	8,143	14.1%	11,415	14.7%	13.8%	14.5%
Poverty 2*	9,954	9.9%	12,596	10.0%	5,434	9.4%	7,433	9.6%	8.7%	9.0%
Poverty 3*	9,448	9.4%	11,763	9.4%	5,201	9.0%	6,982	9.0%	8.3%	8.5%
<b>Quintile 1</b>	<b>21,537</b>	<b>21.5%</b>	<b>26,783</b>	<b>21.3%</b>	<b>11,352</b>	<b>19.6%</b>	<b>15,803</b>	<b>20.3%</b>	<b>21%</b>	<b>20%</b>
Hispanic	8,846	8.8%	16,715	13.3%	5,168	8.9%	10,658	13.7%	6.4%	10.8%
NH White	7,236	7.2%	3,374	2.7%	4,493	7.8%	2,449	3.2%	9.4%	4.2%
NH Black	2,804	2.8%	2,661	2.1%	531	0.9%	829	1.1%	2.4%	1.8%
NH NA	127	0.1%	151	0.1%	74	0.1%	122	0.2%	0.1%	0.1%
NH Asian	2,048	2.0%	3,156	2.5%	880	1.5%	1,378	1.8%	1.7%	2.4%
NH Others	475	0.5%	727	0.6%	206	0.4%	368	0.5%	0.5%	0.7%
<b>Quintile 2</b>	<b>22,532</b>	<b>22.5%</b>	<b>27,629</b>	<b>22.0%</b>	<b>12,603</b>	<b>21.8%</b>	<b>16,565</b>	<b>21.3%</b>	<b>20%</b>	<b>20%</b>
Hispanic	12,202	12.2%	18,317	14.6%	6,909	12.0%	11,280	14.5%	8.5%	11.5%
NH White	5,926	5.9%	3,937	3.1%	3,965	6.9%	2,911	3.7%	7.3%	4.3%
NH Black	1,927	1.9%	2,013	1.6%	491	0.9%	683	0.9%	1.6%	1.3%
NH NA	104	0.1%	143	0.1%	86	0.1%	131	0.2%	0.1%	0.1%
NH Asian	1,794	1.8%	2,435	1.9%	849	1.5%	1,112	1.4%	1.7%	1.9%
NH Others	579	0.6%	784	0.6%	303	0.5%	448	0.6%	0.6%	0.8%
<b>Quintile 3</b>	<b>21,830</b>	<b>21.8%</b>	<b>26,957</b>	<b>21.4%</b>	<b>12,687</b>	<b>22.0%</b>	<b>16,742</b>	<b>21.6%</b>	<b>20%</b>	<b>20%</b>
Hispanic	10,733	10.7%	16,562	13.2%	6,313	10.9%	10,473	13.5%	7.4%	10.4%
NH White	6,695	6.7%	4,792	3.8%	4,539	7.9%	3,647	4.7%	8.4%	5.1%
NH Black	1,691	1.7%	1,793	1.4%	405	0.7%	586	0.8%	1.4%	1.2%
NH NA	107	0.1%	137	0.1%	76	0.1%	117	0.2%	0.1%	0.1%
NH Asian	2,081	2.1%	2,909	2.3%	1,041	1.8%	1,421	1.8%	1.9%	2.3%
NH Others	523	0.5%	763	0.6%	313	0.5%	498	0.6%	0.6%	0.7%
<b>Quintile 4</b>	<b>19,606</b>	<b>19.6%</b>	<b>25,133</b>	<b>20.0%</b>	<b>11,938</b>	<b>20.7%</b>	<b>15,842</b>	<b>20.4%</b>	<b>20%</b>	<b>20%</b>
Hispanic	8,225	8.2%	13,637	10.8%	4,765	8.2%	8,600	11.1%	5.8%	8.8%
NH White	6,983	7.0%	5,422	4.3%	5,303	9.2%	4,382	5.6%	9.9%	6.4%
NH Black	1,353	1.3%	1,635	1.3%	330	0.6%	521	0.7%	1.3%	1.2%
NH NA	116	0.1%	190	0.2%	71	0.1%	106	0.1%	0.1%	0.1%
NH Asian	2,446	2.4%	3,536	2.8%	1,209	2.1%	1,843	2.4%	2.3%	2.9%
NH Others	484	0.5%	713	0.6%	260	0.4%	389	0.5%	0.5%	0.6%
<b>Quintile 5</b>	<b>14,742</b>	<b>14.7%</b>	<b>19,302</b>	<b>15.3%</b>	<b>9,215</b>	<b>15.9%</b>	<b>12,734</b>	<b>16.4%</b>	<b>20%</b>	<b>20%</b>
Hispanic	4,611	4.6%	9,013	7.2%	2,564	4.4%	5,578	7.2%	3.9%	7.1%
NH White	6,434	6.4%	5,099	4.1%	4,932	8.5%	4,295	5.5%	12.1%	7.9%
NH Black	1,081	1.1%	1,355	1.1%	325	0.6%	549	0.7%	1.0%	1.0%
NH NA	75	0.1%	143	0.1%	69	0.1%	111	0.1%	0.1%	0.1%
NH Asian	2,176	2.2%	3,070	2.4%	1,097	1.9%	1,777	2.3%	2.5%	3.4%
NH Others	365	0.4%	623	0.5%	227	0.4%	423	0.5%	0.4%	0.6%

\* Poverty 1 = # of household below poverty; Poverty 2 = # of household between poverty and 1.5xP; Poverty 3 = # of household between 1.5xP and 2.0xP

Source: Based on 2000 Census and 2005-09 ACS, processed and projected by SCAG Research and Analysis staff

### 280 **Projected Growth Changes of Environmental Justice Population Groups**

281 In addition to the spatial distribution analyses of Environmental Justice population groups along major  
 282 truck and freight rail corridors, the historical growth changes of each Environmental Justice population  
 283 group and its share change from 2008 to 2035 were estimated. Table 2 summarizes the projected growth  
 284 and share changes within TAZs in proximity to major truck and freight rail corridors. The share of  
 285 minority population is expected to increase by approximately 7.7 percent in areas adjacent to major truck  
 286 corridors while the share of minority population in areas adjacent to freight rail corridors is expected to  
 287 increase by approximately 10.4 percent. The growth rates in elderly, young children and disabled  
 288 population are projected to be relatively higher in areas adjacent to freight rail corridors than areas  
 289 adjacent to major truck corridors, while both areas show similar share changes. And, the growth rate and  
 290 share change in households below poverty level are projected to be relatively higher in areas adjacent to  
 291 freight rail corridors. In general, compared with TAZs within 500 feet from major truck corridors, TAZs  
 292 within 500 feet from freight rail corridors are expected to have higher growth rates of Environmental  
 293 Justice population groups, indicating that concentration of the Environmental Justice population groups  
 294 could be relatively higher in areas adjacent to freight rail corridors than areas adjacent to major truck  
 295 corridors.

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297 **TABLE 2 Projected Growth Rates and Share Change of Environmental Justice Population**  
 298 **Groups along Major Truck and Freight Rail Corridors: From 2008 to 2035**

	500 Feet from Major Truck Corridors		500 Feet from Freight Rail Corridors		SCAG Region
	Growth %	Share Change	Growth %	Share Change	Share Change
Hispanic	41.8%	8.6%	56.8%	10.3%	10.6%
NH White	-18.1%	-7.7%	-15.5%	-10.4%	-10.9%
NH Black	7.3%	-0.9%	47.6%	0.4%	-0.8%
NH NA	31.1%	0.0%	42.8%	0.0%	0.1%
NH Asian	21.9%	-0.1%	28.1%	-0.3%	0.8%
NH Others	29.0%	0.1%	37.3%	0.1%	0.2%
Age 65 & Above	102.5%	5.9%	119.3%	5.9%	6.3%
Age 5 & Below	15.5%	-0.6%	23.3%	-0.7%	-0.5%
Disabled	33.0%	0.8%	43.5%	0.7%	0.8%
Poverty 1*	25.9%	0.1%	40.2%	0.6%	0.7%
Poverty 2*	26.5%	0.1%	36.8%	0.2%	0.4%
Poverty 3*	24.5%	-0.1%	34.3%	0.0%	0.2%

\* Poverty 1 = # of household below poverty; Poverty 2 = # of household between poverty and 1.5xP; Poverty 3 = # of household between 1.5xP and 2.0xP

Source: Based on 2000 Census and 2005-09 ACS, processed and projected by SCAG Research and Analysis staff

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### 300 **Emission Intensity Distribution along Major Truck Corridors**

301 Table 3 summarizes the emission intensity estimates for ROG, CO, CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, PM<sub>2.5</sub> within TAZs  
 302 in proximity to major truck corridors for the year 2008. It compares the emission intensity of areas within  
 303 500 feet from major truck corridors with areas within 500 feet from freeways in the SCAG Region.  
 304 Column (c) of Table 3 represents the percentage increase/decrease of emission intensity within areas  
 305 along major truck corridors, compared with the regional level. Higher emission intensity was observed  
 306 within areas along major truck corridors than the regional level in every emission factor. It was estimated  
 307 that areas in proximity to major truck corridors show approximately 20 percent of CO and CO<sub>2</sub> emission  
 308 intensity and over 30 percent of PM<sub>2.5</sub> emission intensity more than the regional level.

309 The emission data used in the research includes emissions from both passenger car and truck  
 310 movement. In order to better assess the impacts of truck movement separately from passenger cars,  
 311 SCAG estimated the vehicle-miles traveled (VMT) for truck movement for the major truck corridors, and  
 312 then, compared it with the rest of freeways in the SCAG Region. Table 4 summarizes the total and truck

313 VMTs for major truck corridors and for the rest of freeways in the SCAG Region in 2008. As shown in  
 314 the table, it is estimated that 12.6% of total VMT for major truck corridors is truck VMT while only 7%  
 315 of total VMT for the rest of freeways in the SCAG Region is truck VMT. And, it is also estimated that  
 316 truck VMT for major truck corridors accounts for approximately 63% of total truck VMT of the SCAG  
 317 Region while the length of major truck corridors accounts for 26% of total length of freeways in the  
 318 SCAG Region. These observations suggest that there is a high concentration of truck movements on  
 319 major truck corridors, compared with the rest of freeways in the SCAG Region. Therefore, given the  
 320 results from Tables 3 and 4, it is implied that there could be more adverse environmental impacts on areas  
 321 along freight truck corridors resulting from the significant amount of truck movements. Considering the  
 322 concentration of the Environmental Justice population groups along major truck corridors, the results  
 323 indicate that there could be potential disproportionate environmental impacts from truck movement on the  
 324 Environmental Justice population groups living in proximity to major truck corridors.

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**TABLE 3 Emission Intensity Estimates for Areas Along Major Truck Corridors: 2008**

Emission Factors	Emission Intensity (gram/day/acre)		Intensity Comparison* (Major Truck Corridors vs. Freeways in SCAG Region)
	500 Feet from Major Truck Corridors	500 Feet from Freeways in SCAG Region	
	(a)	(b)	(c)
Reactive Organic Gases (ROG)	4.99	4.04	23.4%
Carbon Monoxide (CO)	93.99	78.52	19.7%
Carbon Dioxide (CO <sub>2</sub> )	11,996.31	9,997.03	20.0%
Oxides of Nitrogen (NO <sub>x</sub> )	29.95	23.09	29.7%
Sulfur Dioxide (SO <sub>2</sub> )	0.12	0.10	19.9%
Particulate Matter (PM <sub>2.5</sub> )	1.12	0.85	32.6%

\* Percentage increase/decrease of emission intensity within areas along major truck corridors, compared to areas along freeways in the SCAG Region. (For example, (c) was calculated by (a) minus (b) divided by (b).)

Source: SCAG Emissions Impact Study

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**TABLE 4 Comparison of Truck VMT for Major Truck Corridors and the Rest of Freeways in the SCAG Region: 2008**

	Length (mi.)	Total VMT (thousands)	Truck VMT (thousands)	Share of Truck VMT
Major Truck Corridors	1,810 (26%)	124,940 (49%)	15,693 (63%)	12.6%
The Rest of Freeways	5,210 (74%)	131,240 (51%)	9,207 (37%)	7.0%
Freeways in SCAG Region	7,020	256,180	24,901	9.7%

(Source: SCAG model data, 2012)

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Figure 1 depicts major truck corridors and freeway systems in the Los Angeles metropolitan area, and also the spatial distribution of carbon dioxide emission intensity by TAZ for the year 2008. As shown in the map, high concentration of emissions is observed along freeways, especially along major truck corridors.

337 **FIGURE 1 CO<sub>2</sub> Emission Intensity by TAZ in the Los Angeles Metropolitan Area: 2008.**

338

339 **CONCLUSION**

340 This paper presented the distribution of Environmental Justice population groups in areas adjacent to  
 341 major truck and freight rail corridors. In order to assess the concentration of the Environmental Justice  
 342 population groups along goods movement corridors, a comparative analysis method was conducted to  
 343 examine the distribution of socioeconomic indicators between areas adjacent to major truck and freight  
 344 rail corridors and the SCAG Region. Socioeconomic indicators were selected based on Environmental  
 345 Justice guidelines to define Environmental Justice population groups. Then, distance criteria from major  
 346 truck and freight rail corridors was determined based on guidance and recommendations from various  
 347 organizations. For distribution analysis of the Environmental Justice population groups, a residential area-  
 348 weighted interpolation method was used to estimate population within 500 foot buffer areas. The results  
 349 of this research indicate higher concentration of the Environmental Justice population groups within areas  
 350 adjacent to major truck and freight rail corridors than the regional average, implying potential  
 351 disproportionately high and adverse human health or environmental effects on the Environmental Justice  
 352 population groups from the goods movement system; however, further analysis is needed to verify these  
 353 observations.

354 Also, the research compared the projected growth and share changes between areas adjacent to  
 355 major truck and freight rail corridors. The results indicate that higher concentration of the Environmental  
 356 Justice population groups is expected in areas adjacent to freight rail corridors. In addition, the research  
 357 estimated emission intensity for emission factors within areas adjacent to major truck corridors, and then,  
 358 compared it with emission intensity within areas adjacent to freeways in the SCAG Region. The results  
 359 indicate that areas adjacent to major truck corridors are expected to experience more adverse  
 360 environmental burdens than the regional level, raising potential Environmental Justice concerns, given the  
 361 higher concentration of the Environmental Justice population groups within areas adjacent to major truck  
 362 corridors.

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364 **Areas for Future Research**

365 Considering that the goods movement system is expected to increase in the SCAG Region in the future,  
366 additional research and analysis is needed to understand the future Environmental Justice issues relevant  
367 to the goods movement system. In addition to estimation of truck-related emission intensity along major  
368 truck corridors, similar analysis is needed to estimate freight rail-related emission estimates and emission  
369 intensity distribution within areas adjacent to freight rail corridors. Also, further analysis is necessary to  
370 examine the environmental impacts of rail-related facilities in connection with ports and major rail yards  
371 in the SCAG Region, given the expected growth in international trade and domestic goods movement in  
372 the future.

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