

8. Environmental Justice and Sensitive Populations

8.1 Introduction

8.1.2 Environmental Justice Defined

Environmental Justice entails the fair treatment and meaningful involvement of all people regardless of race, age, gender, national origin, education or income level, in the development, implementation and enforcement of environmental laws, regulations and policies. Since the early 1980s, there has been increasing awareness of disproportionate effects of environmental hazards on minority and low-income communities. Environmental justice will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, play, and work.

8.1.3 Oregon Direction on Environmental Justice

In 2007, as a result of a sustained effort by Senator Avel Gordly, the Oregon Legislature passed Senate Bill 420 creating the Environmental Justice Task Force to advise the Governor and natural resource agencies on environmental justice issues. ORS 182.545 directs DEQ and all other natural resource agencies to (1) consider the effects of agency action on environmental justice issues; (2) hold hearings at times and in locations that are convenient for people in the communities that will be affected by the decisions stemming from the hearings; (3) engage in public outreach activities in the communities that will be affected by decisions of the agency; and (4) create a Citizen Advocate position that is responsible for encouraging public participation, ensuring the agency considers environmental justice in its decisions, and informs the agency of the effects of its decisions on low-income communities, communities of color and other populations traditionally underrepresented in agency decision-making.

DEQ first adopted an Environmental Justice policy in 1997 to guide the agency's work, including principles for making environmental justice inherent in the way DEQ does business. DEQ is committed to ensuring that its actions – including permitting, cleanup, policy and planning, outreach and education, and compliance and enforcement – address the interests of all Oregonians regardless of race, age, gender, national origin, education or income level. One of the considerations in developing an air toxics reduction plan for the Portland area is the effect of potential toxics reduction strategies on environmental justice communities. For more information on environmental justice at DEQ, visit <http://www.deq.state.or.us/about/envjustice.htm>.

8.1.4 Purpose of Environmental Justice Analysis in PATS

DEQ, with input from PATSAC, used 2017 modeling and demographic data to determine where there are disproportionate impacts from air toxics on low-income and minority populations in the PATS study area. The study area includes portions of Multnomah, Washington and Clackamas counties. Using four different methods of examining the data, DEQ concluded that low-income and minority communities are disproportionately impacted by higher concentrations of air toxics compared to mid to high income primarily white communities in the PATS study area. The details of analysis in this section demonstrate the degrees to which disparities exist.

8.1.5 Using Environmental Justice Information

The PATS environmental justice analysis is the first investigation that DEQ has performed to understand disparate impacts by pairing environmental data with demographic data from the Census. PATS committee members, EPA Region 10, and academic researchers assisted DEQ in conducting this analysis. DEQ plans to factor environmental justice considerations into future strategies to reduce emissions from priority categories (see [section 9.3](#)). The priority categories for emission reductions in the short term are residential wood combustion, on road light duty engines (mostly gasoline), on road heavy duty engines (mostly diesel), construction (mostly diesel engines) and industrial metals. This analysis is an important first step in planning

emission reductions for the Portland area. It also serves as an example and foundation for similar efforts within DEQ and partner agencies.

8.2 PATS Environmental Justice Analysis

8.2.1 Summary of Environmental Justice Analysis

The PATS environmental justice analysis demonstrated the existence of disproportionate impacts from air toxics on minority and low-income populations in the Portland area. Different minority groups are affected by different types of emission sources. In general, DEQ found that the Hispanic/Latino population experienced the highest impacts from residential wood combustion emissions, the Asian population from on-road mobile emissions, the African American/Black population from area source emissions, and the population living below the poverty level from on-road mobile emissions. Non-road mobile emissions also significantly impact minority populations, while point sources disproportionately impact populations living below the poverty level. This information should be incorporated into emission reduction strategies and used by communities and local government to prioritize efforts to improve public health.

8.2.2 PATS Environmental Justice Methodology and Results

To determine the degree to which air toxics disproportionately impact environmental justice communities in the study area, DEQ took the following steps:

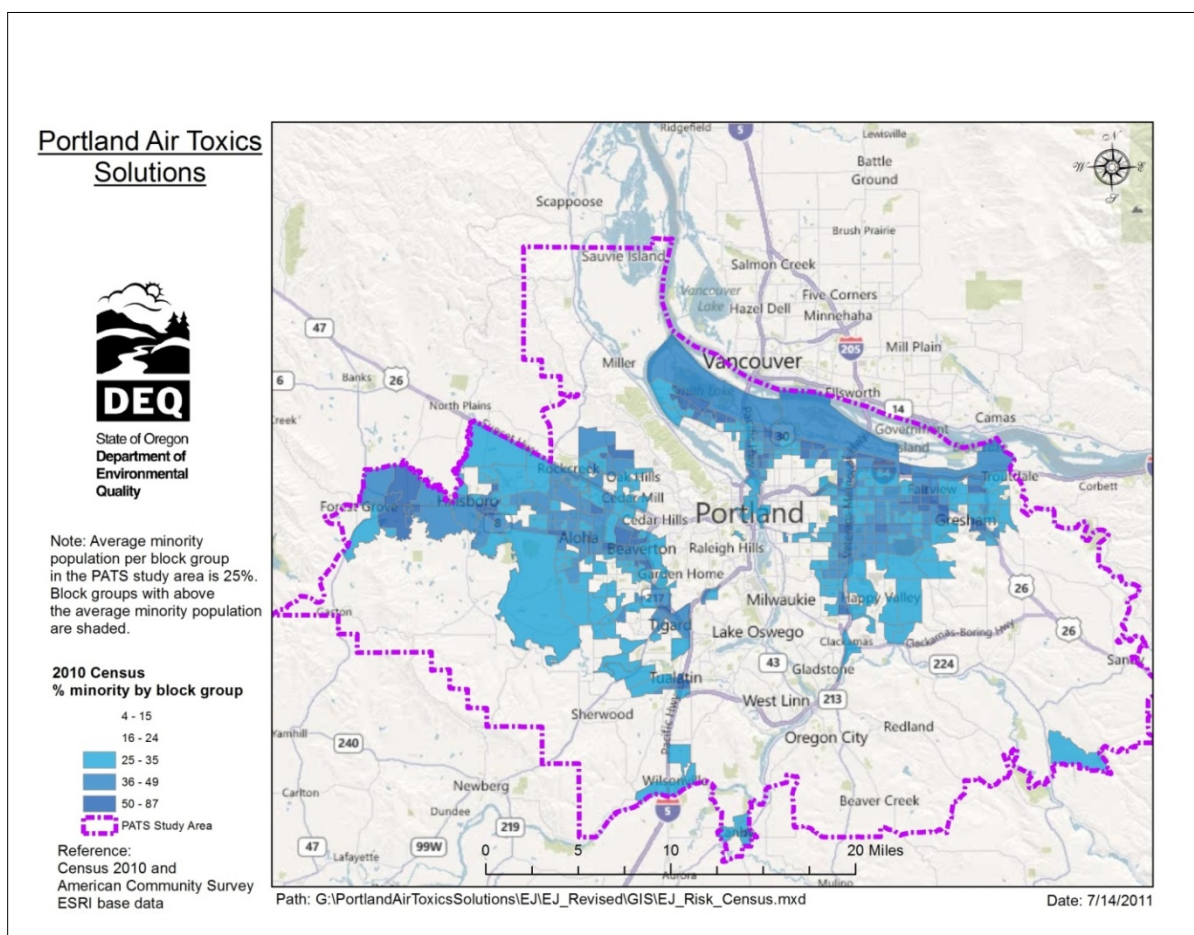
1. Visual inspection of maps created using GIS
2. Performing a cumulative distribution analysis of differences between minority and white populations
3. Using bar graphs to assess impacts in high minority and low income areas
4. Multivariate linear regression modeling to examine relationships between several factors at a time

For this analysis, DEQ used U.S. Census Bureau 2010 data at the block group level. Due to changes in the Census, income data is no longer available from the decennial Census data. DEQ relied on the American Community Survey (ACS) 5-year estimate (2005-2009) to determine median household income and an income to poverty ratio by block group. ACS is part of the assessment conducted by the U.S. Census Bureau with the primary purpose of measuring the changing social and economic characteristics of the U.S. population. The ACS collects data every year, but the ACS sample is smaller than that of the Census long-form sample. The ACS combines population or housing data from multiple years to produce reliable numbers for local areas. As a result of ACS data's relatively large confidence intervals for smaller geographic areas, DEQ has more confidence in the analysis of race and ethnicity disparities than income level data.

8.2.2.1 Visual Inspection through GIS Mapping

To conduct a visual inspection of the extent to which minority populations were exposed to modeled levels of air toxics, DEQ created an overlay of minority populations on all pollutants above benchmarks in the 2017 model. DEQ mapped all potential EJ areas based on the percent of minority population. Minority status includes all persons not claiming single race non-Latino white status on the 2010 Census. In Portland, the average minority population is 25%. Therefore, potential EJ areas in this analysis are defined as having higher than 25% minority population. Figure 104 shows the block groups that are identified as potential EJ areas based on minority status.

Figure 104: 2010 Census Minority Population by Block Group



In Figure 105 the block groups with minority populations above 25% are layered on a map showing total times above benchmarks for all PATS pollutants. Visual inspection of this overlay suggests that there is an overlap between high minority and high impact areas in some areas of the PATS study boundary. Those areas include Forest Grove, Hillsboro, Aloha, Beaverton, North Portland, East Portland and Gresham.

Figure 105: Cumulative Benchmark Exceedances from All Source Categories and Percent Minority by Block Group

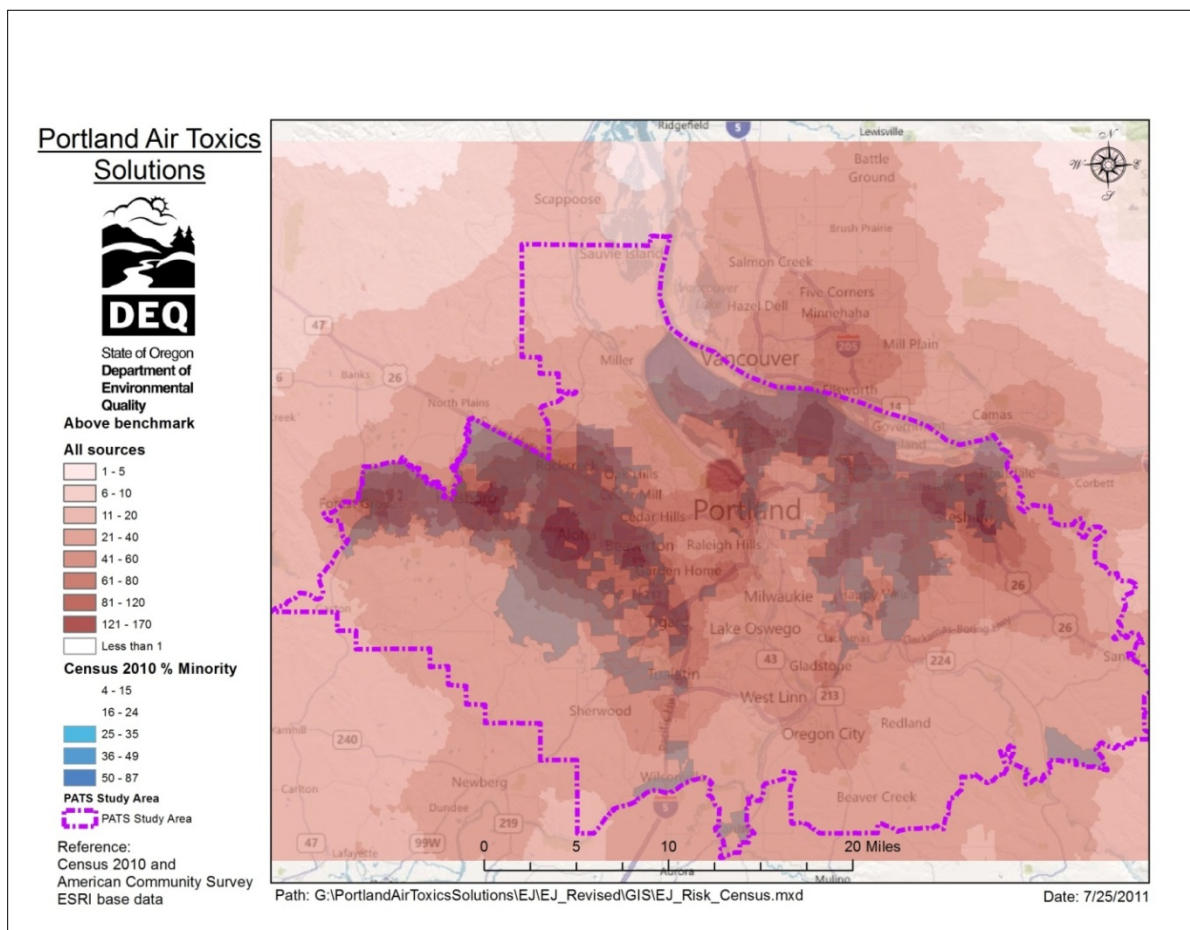


Figure 106 shows an overlay of minority populations on risk from residential wood combustion. Visual inspection of this overlay suggests a significant overlap between high minority populations and areas with elevated risk from wood combustion. By contrast, Figure 107 shows an overlay of minority populations and risk from industrial point sources with less overlap or impact on minority populations. Based on this step of visual inspection, PATSAC requested that DEQ conduct further analysis to quantify the extent of the disparity between the minority and white populations. Overlay maps for additional categories of emissions may be found in [Appendix 10.14](#).

Figure 106: Cumulative Benchmark Exceedances from Residential Wood Combustion and Percent Minority by Block Group

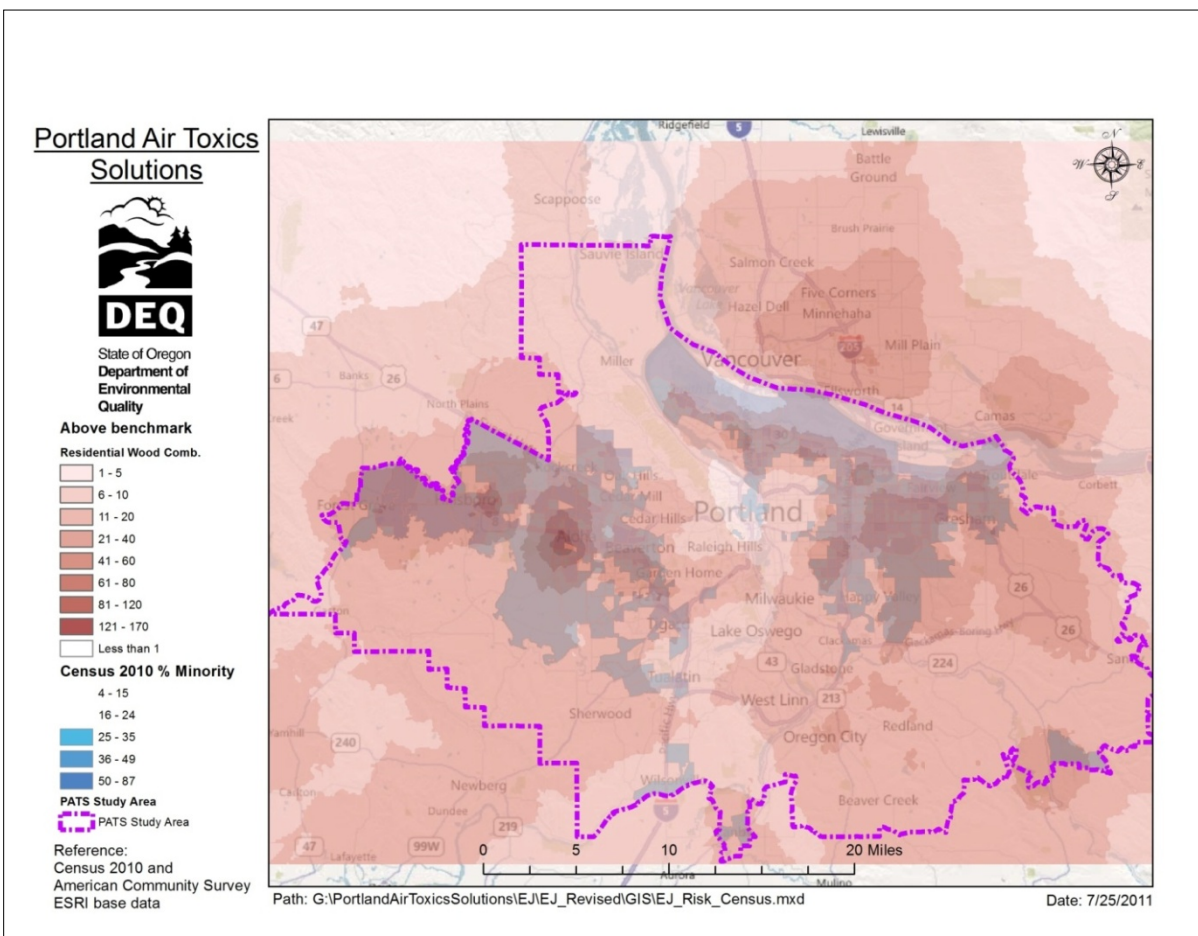
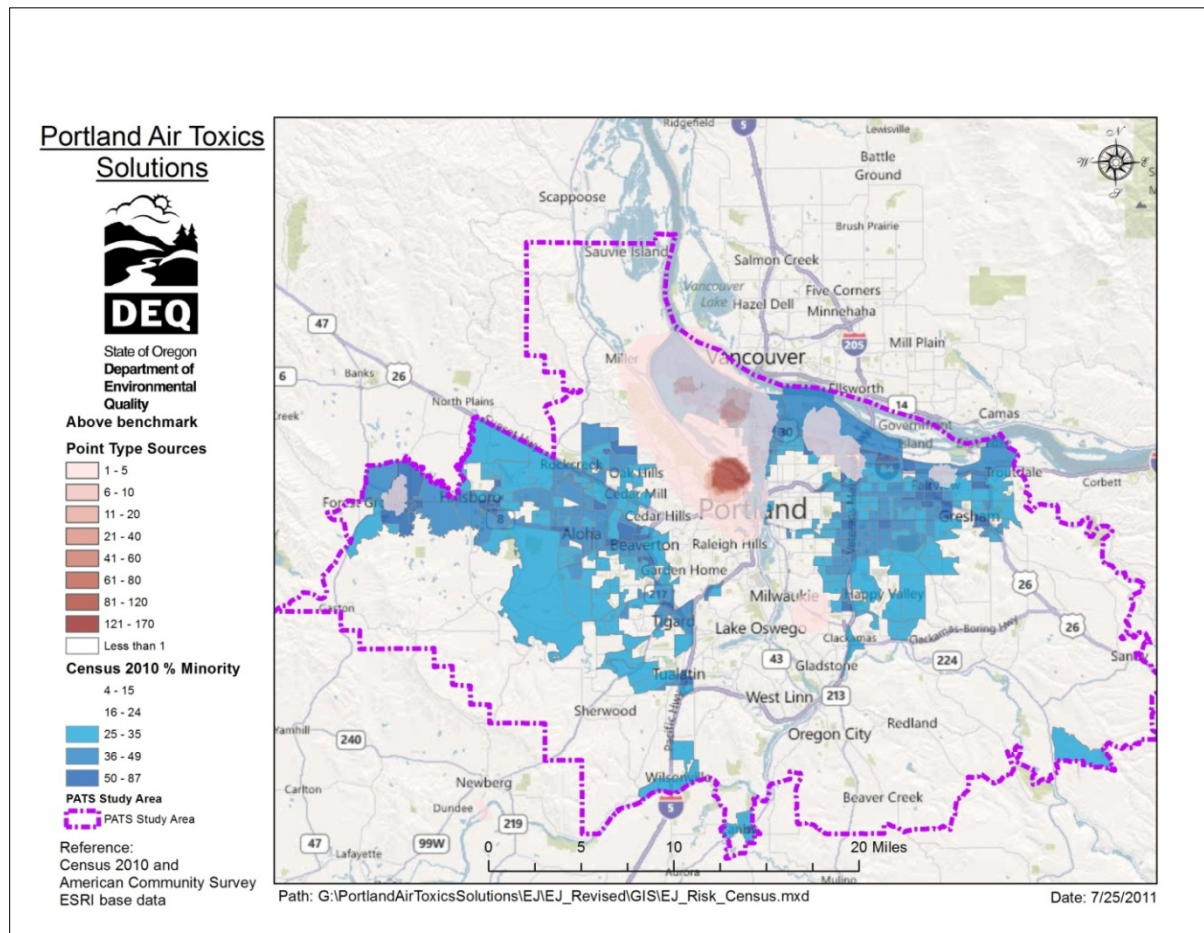


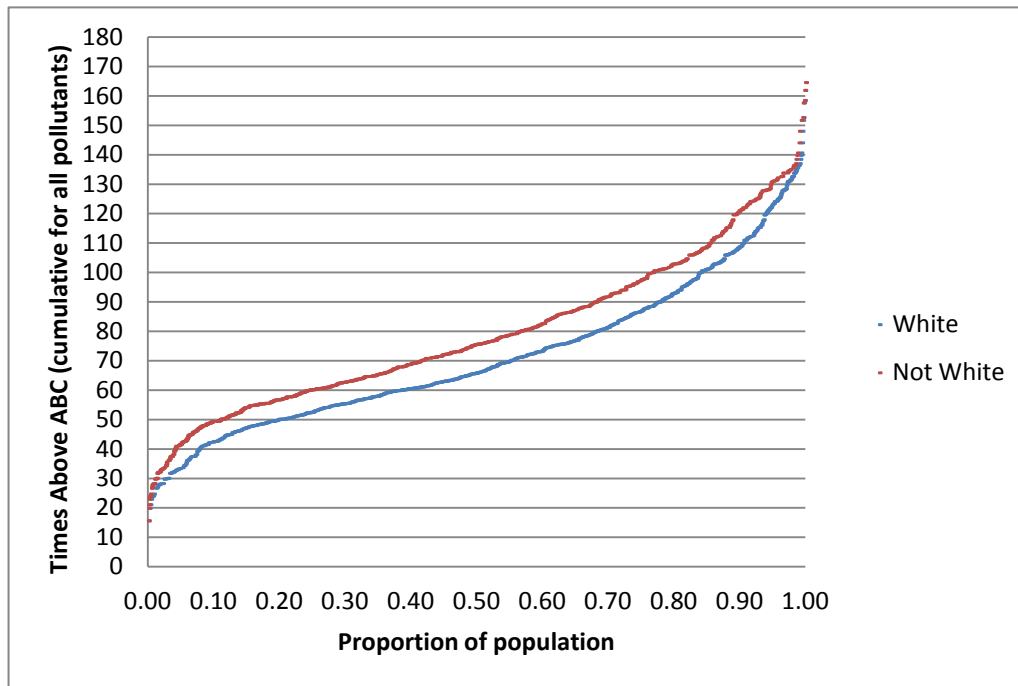
Figure 107: Cumulative Benchmark Exceedances from Point Sources and Percent Minority by Block Group



8.2.2.2 Performing a Cumulative Distribution Function

To gain a better quantitative understanding of environmental justice air toxics impacts in the Portland region, DEQ performed a cumulative distribution function (CDF) analysis (Waller et al.1999). DEQ analyzed the cumulative times above benchmark values at the block group level for white and minority populations. The y-axis represents cumulative times above benchmark values and the x-axis represents the fraction of the population exposed (from 0 to 1). Figure 108 shows the CDF curves for the two population subgroups. The gap between these two curves indicates that a larger proportion of minorities reside in block groups with higher risk. For example, 50% of white residents are exposed to levels of air toxics more than 65 times above health-based benchmarks, while 50% of minority residents are exposed to levels of air toxics more than 75 times above health-based benchmarks from all emission sources.

Figure 108: Cumulative Distribution Function of modeled air toxics impact from all source categories for White and Non-White Population: PATS 2017 Model Results: Cumulative Benchmark Exceedances From All Emission Source Categories



CDF analysis can be applied to individual source categories. Figure 109 and Figure 110 show results for two source categories: residential wood combustion and point sources. CDF curves of modeled residential wood combustion are similar to curves for all emission sources, although the disparity increases as wood smoke emissions increase. CDF curves of modeled point sources show that only 10% of the population in the study area experiences impacts above health-based benchmarks, with several block groups experiencing very high adverse impacts. CDF curves for whites and minority populations in Figure 110 do not indicate disproportionate impact on the non-white population.

Figure 109: Cumulative Distribution Function of modeled air toxics impact from residential wood combustion for White and Non-White Population

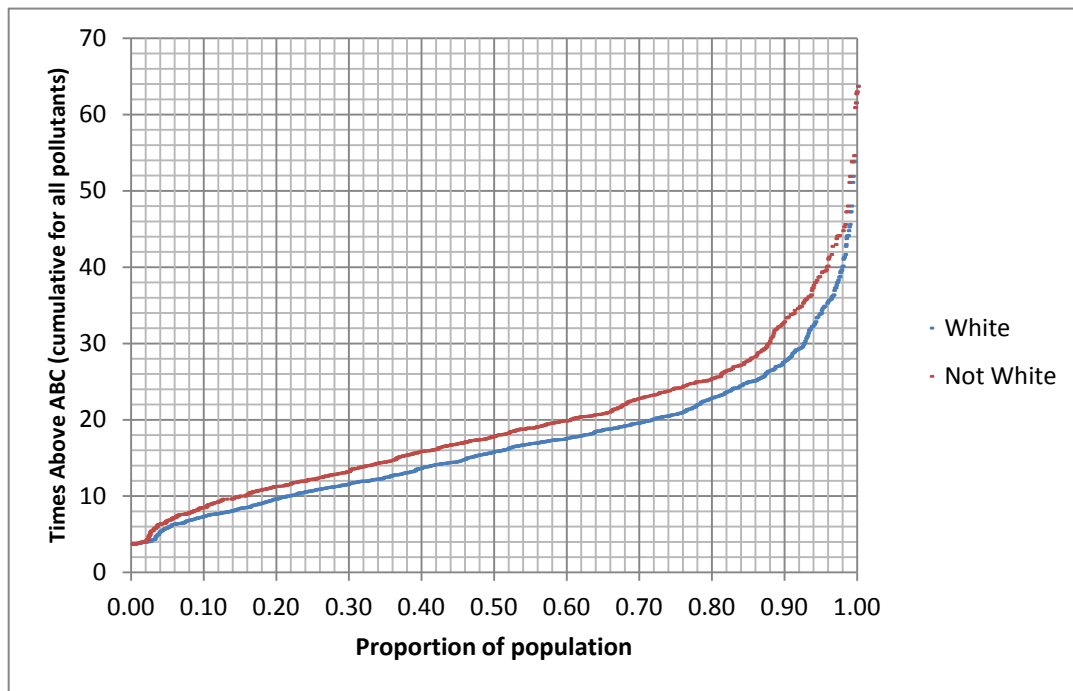
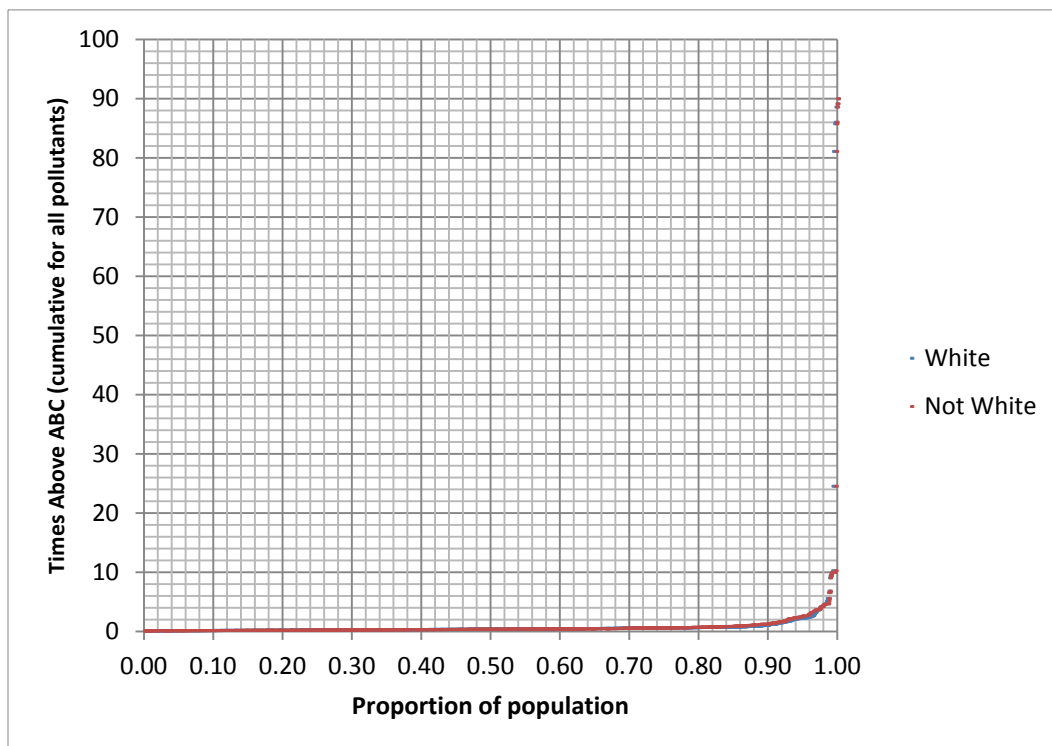


Figure 110: Cumulative Distribution Function of modeled air toxics impact from point sources for White and Non-White Population



8.2.2.3. Assessment of impacts in high minority and lowest income areas

Another way to consider EJ impacts is to focus on the areas with the highest minority and lowest income populations. DEQ selected ten block groups that rated highest for each of these two categories and compared the impacts in those block groups to the average impact within the PATS study area. Highest percent minority block groups were determined based on 2010 Census data, while lowest income block groups were determined based on ACS 12-month median household income data. Figure 111 shows the average benchmark exceedances from all sources and from individual source categories for the PATS study area and for the ten selected block groups for both race and socioeconomic status. The results indicate that the ten lowest income and ten highest minority block groups experience greater impacts from all sources of air toxics than the average block group in the PATS study area. This is also true for on-road mobile (ORM), non-road mobile (NRM), and area (excluding residential wood combustion) source categories. The block groups with the highest minority populations are exposed to residential wood combustion (RWC) emissions at greater levels than the average block group, while the lowest income block groups are exposed to less RWC emissions. Conversely, the lowest income block groups are disproportionately impacted from point source emissions than the average, while the block groups with the highest minority populations are impacted less than the average. Table 42 summarizes the ratios for average and top-ten values. The ratios show what source categories exhibit the largest deviations from average. A larger positive number in this table means a greater difference from the study area average, while a larger negative number means less exposure than the average for the study area.

Figure 111: Comparison of Times above Benchmark between 10 Selected Block Groups Based on Income and Percentage Minority and Average Times above Benchmark for all Block Groups within PATS Study Area

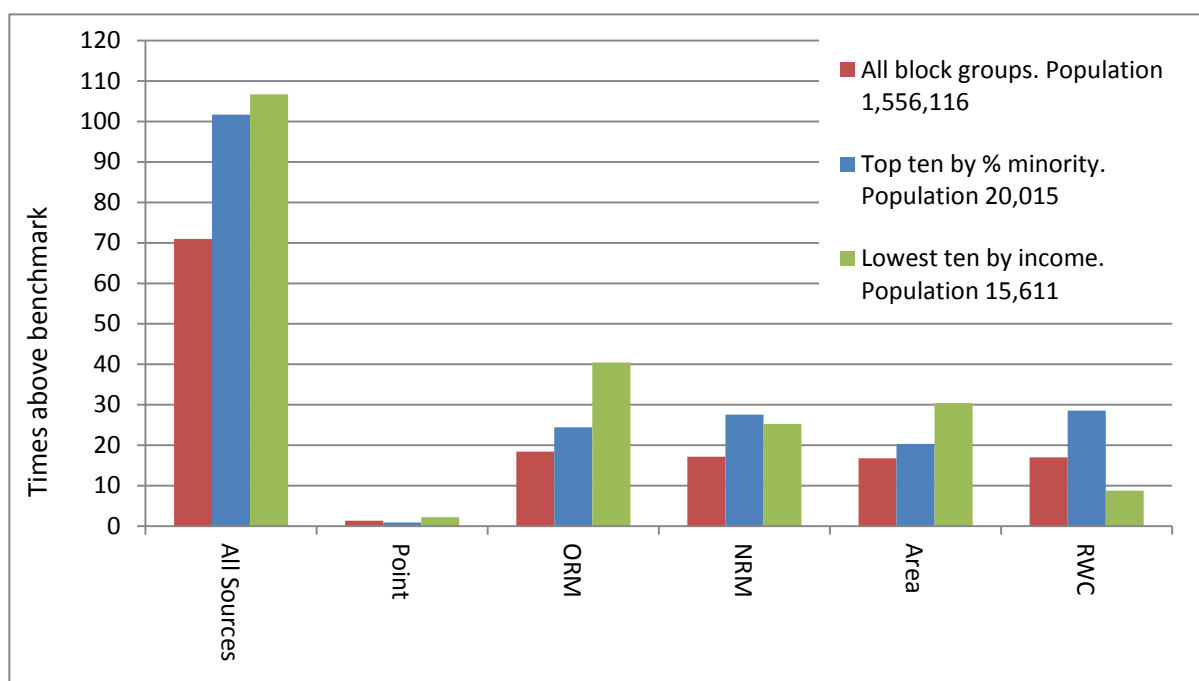
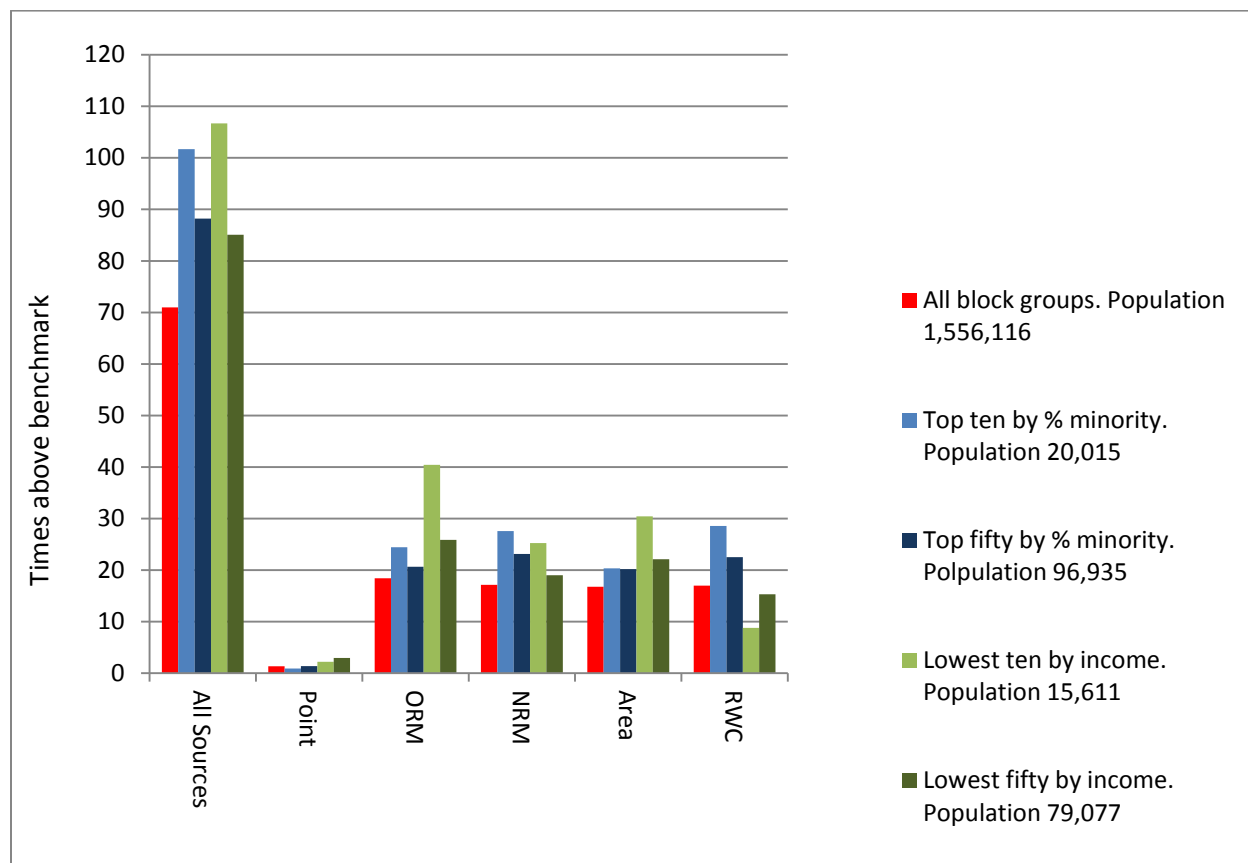


Table 42: Summary of Ratios Comparing Times above Benchmarks

	All Sources	Point Sources	On-road mobile ORM	Non-road mobile NRM	Area (other than residential wood combustion)	Residential Wood Combustion RWC
Top ten by % minority.	1.43	0.68	1.33	1.61	1.21	1.68
Lowest ten by income.	1.50	1.65	2.20	1.47	1.81	0.52

DEQ expanded the number of selected block groups from ten to fifty to determine if the disparate impact trend was consistent. Figure 112 shows that while differential exposure is still present when fifty selected block groups are compared to the average, this disparate exposure is less significant.

Figure 112: Comparison of Times above Benchmark between 10 and 50 Selected Block Groups Based on Income and Percentage Minority and Average Times above Benchmark for all Block Groups within PATS Study Area



The maps in Figure 113, Figure 114, Figure 115, and Figure 116 show the locations of the minority and income categories used in the comparisons of selected block groups.

Figure 113: Ten Lowest Income Block Groups

Portland Air Toxics
Solutions



State of Oregon
Department of
Environmental
Quality

Lowest 10 by median income

Median Household Income

MEDINCOME

0 - 39709

39710 - 56944

56945 - 76883

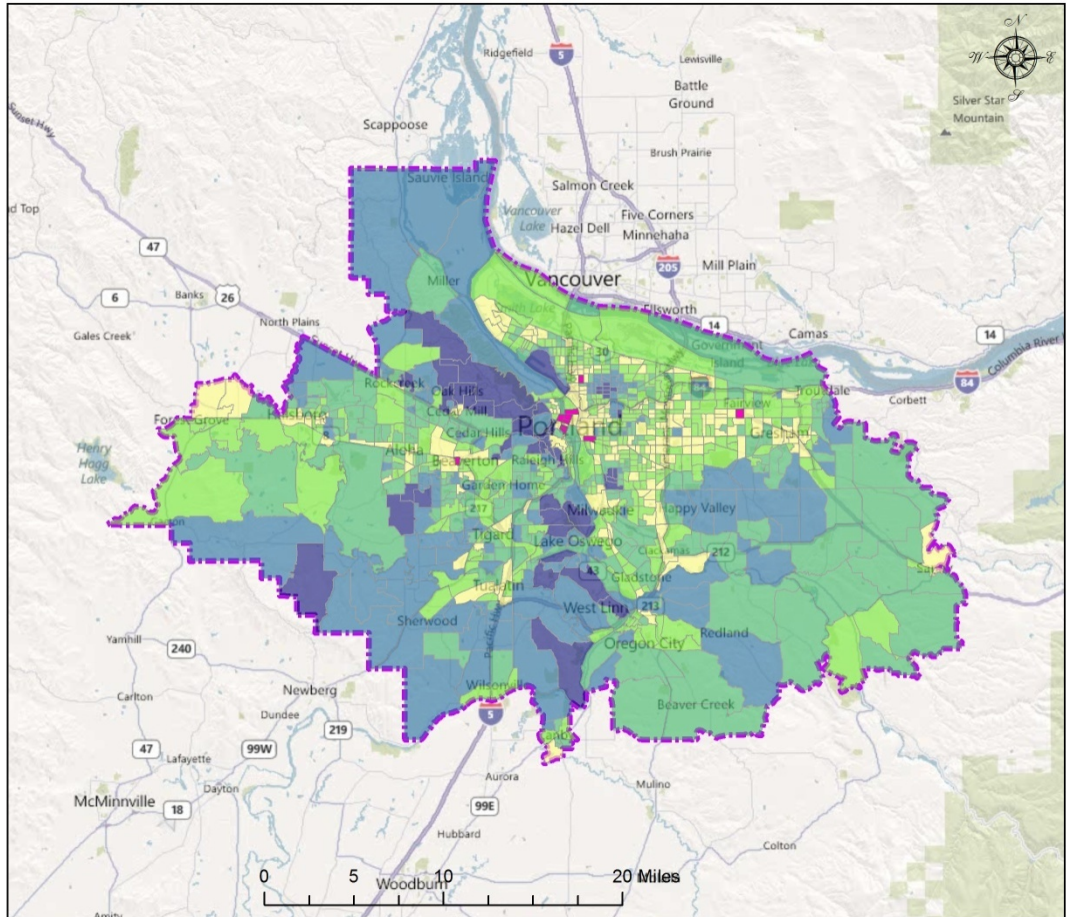
76884 - 106645

106646 - 180864

PATS Study Area

PATS Study Area

Reference:
Census 2010 and
American Community Survey
ESRI base data



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Date: 8/26/2011

Figure 114: Fifty Lowest Income Block Groups

Portland Air Toxics Solutions



State of Oregon
Department of
Environmental
Quality

Lowest 50 by median income

Median Household Income

MEDINCOME

0 - 39709

39710 - 56944

56945 - 76883

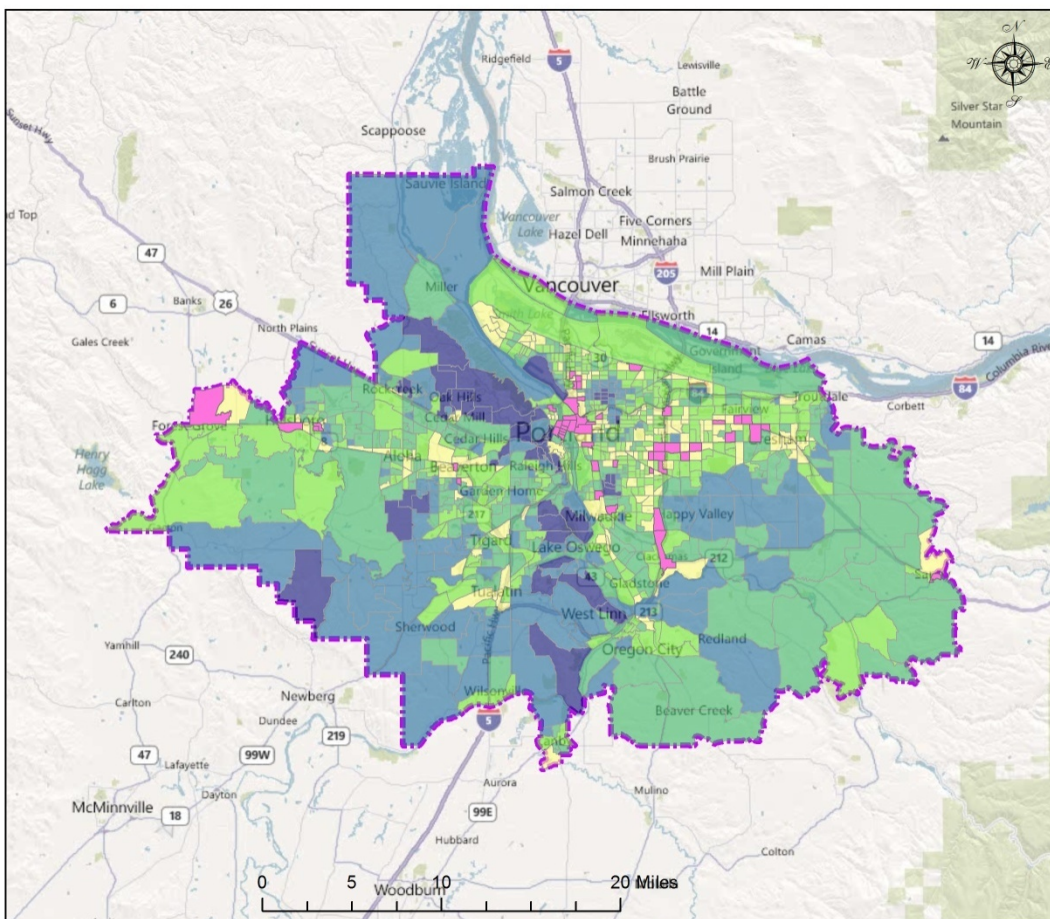
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106646 - 180864

PATS Study Area

PATS Study Area

Reference:
Census 2010 and
American Community Survey
ESRI base data



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Figure 115: Highest Ten Block Groups by Percent Minority

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State of Oregon
Department of
Environmental
Quality

Highest 10 by % minority
Census 2010 % Minority

4 - 15

16 - 24

25 - 35

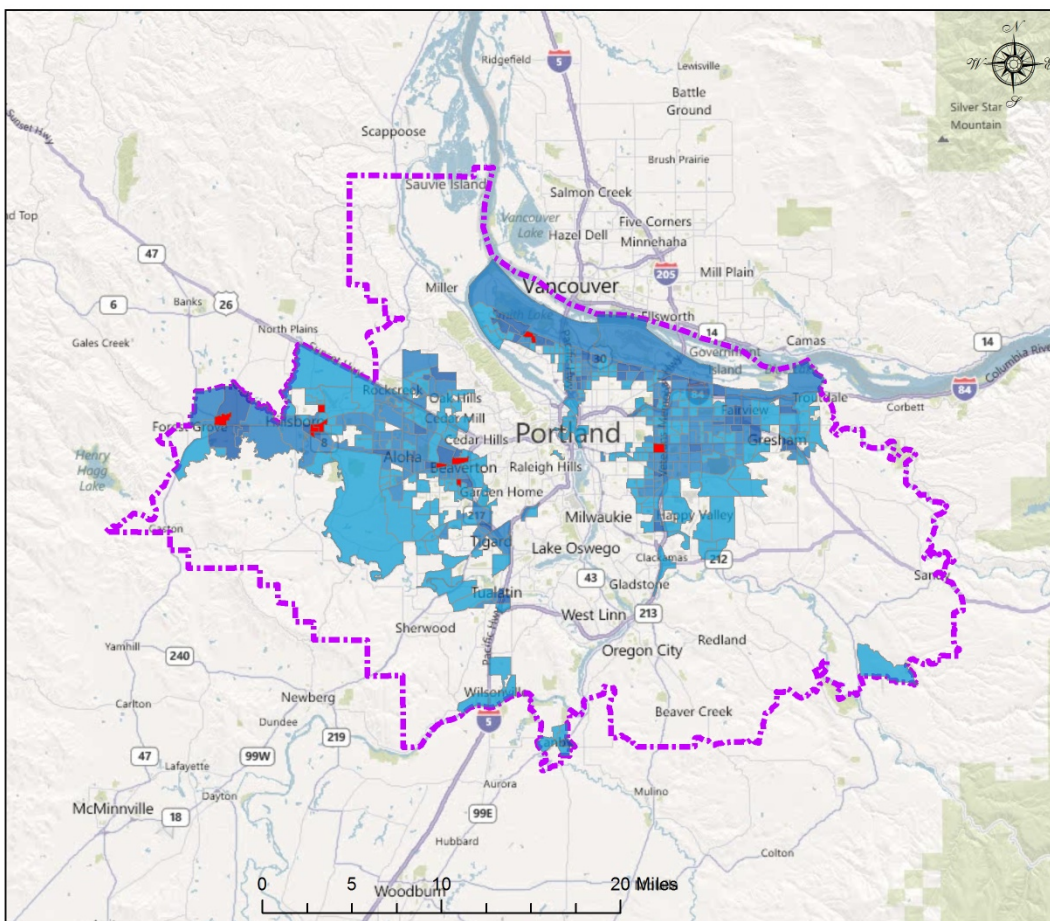
36 - 49

50 - 87

PATS Study Area

PATS Study Area

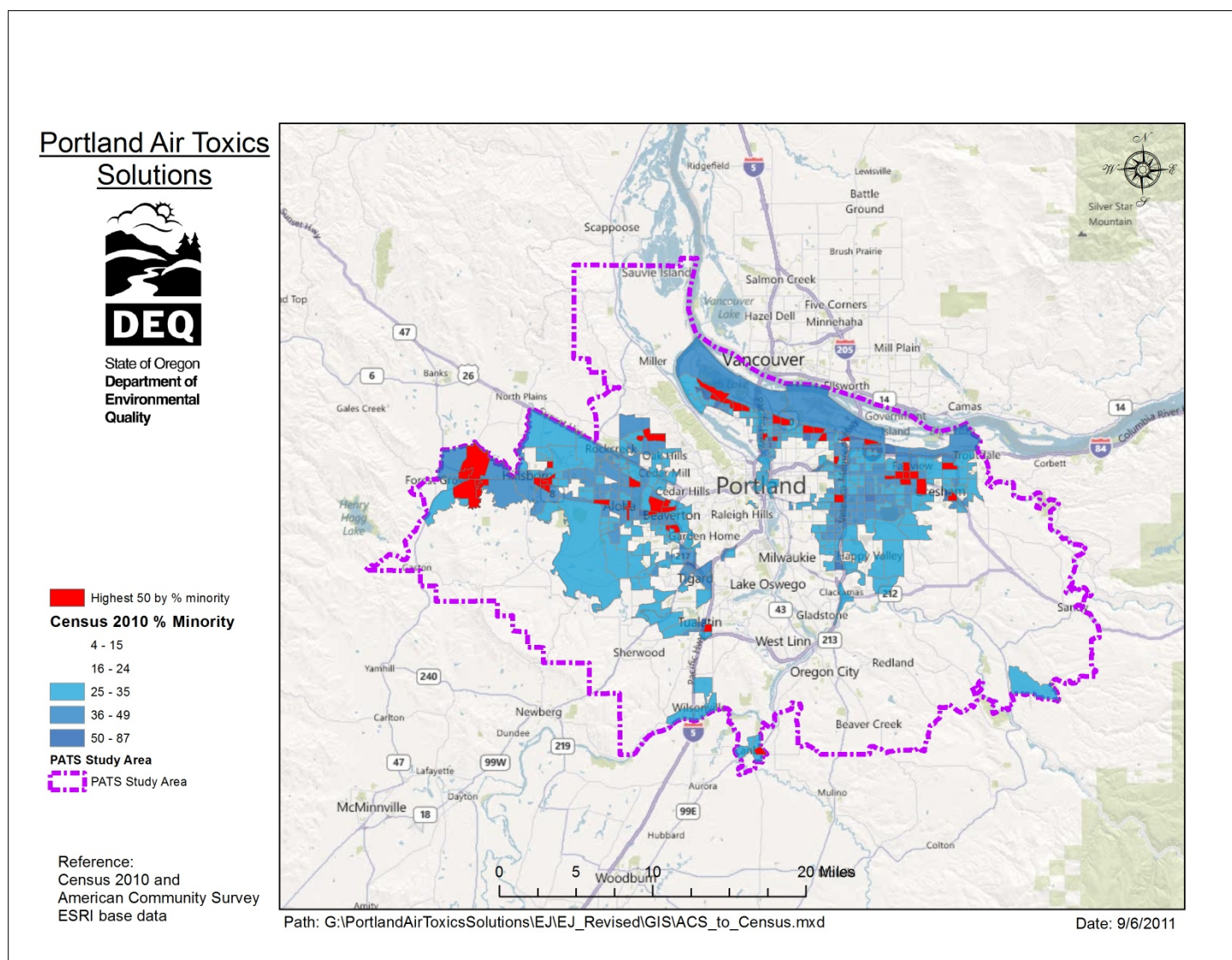
Reference:
Census 2010 and
American Community Survey
ESRI base data



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Figure 116: Highest Fifty Block Groups by Percent Minority



8.2.2.4 Multivariate linear regression modeling

DEQ also performed a statistical analysis of the PATS environmental justice information with a multivariate linear regression model. DEQ assessed multiple social, demographic, and income variables at once using the multiple linear regression (MLR) models. DEQ used MLR models to investigate whether the dependent variable - times above benchmark - is a function of, or is in relationship to the independent or explanatory variables - race and income. The explanatory variables DEQ included in the models are Hispanic/Latino, African American/Black, Asian, and below-poverty populations. Income was considered independently from race and minority status. Table 43 gives an overview of racial/ethnic and socioeconomic characteristics of the PATS study area and air toxics distribution from all sources and by major source category.

**Table 43: Summary Descriptive Statistics for the Variables used in Multivariate
Linear Regression Modeling**

Summary Descriptive Statistics	Percent of Population by 2010 Census Block Group				Times Above Benchmark (TAB): cumulative for all PATS toxics					
	<i>Hispanics/ Latino</i>	<i>African American/ Black</i>	<i>Asian</i>	<i>Below Poverty</i>	<i>Total All Sources</i>	<i>Point Sources</i>	<i>On-Road Mobile</i>	<i>Non-Road Mobile</i>	<i>Area Sources</i>	<i>Residential Wood Comb.</i>
Mean	11.3	3.5	6.0	12.6	71.0	1.3	18.4	17.2	16.8	17.0
Standard Error	0.3	0.2	0.2	0.3	0.8	0.2	0.3	0.3	0.2	0.3
Median	7.4	1.6	4.2	9.8	65.3	0.5	16.4	14.8	16.3	15.8
Standard Deviation	10.5	5.2	5.4	10.5	26.1	6.8	8.5	8.4	6.8	9.4
Minimum	0.0	0.0	0.0	0.0	15.7	0.1	1.7	2.4	2.7	3.7
Maximum	83.0	38.2	45.1	59.8	171.6	89.9	50.5	66.4	36.4	63.7
Count	982	982	982	982	982	982	982	982	982	982

Within the PATS study area, an average of 11.3% Hispanic/Latinos, 3.5% African American/Blacks, 6% Asians, and 12.6% residents below the poverty line reside in each block group. Modeled concentrations are divided by the benchmarks to arrive at times above benchmark (TAB) values for each air toxic. Mean interpolated TAB values from all sources is 71, 1.3 from point sources, 18.4 from on-road mobile, 17.2 from non-road mobile, 16.8 from area sources, and 17 from residential wood combustion. A large standard deviation compared to the mean indicates that there is significant variation in the values by block groups. This can also be observed from the listed minimum and maximum values. A more detailed description of DEQ's statistical analysis may be found in Appendix 10.14.

Figure 117, Figure 118, Figure 119 and Figure 120 show the locations of Hispanic/Latino, African American/Black, Asian, and below poverty populations in the PATS study area.

Figure 117: Percent Hispanic/Latino Population by Block Group

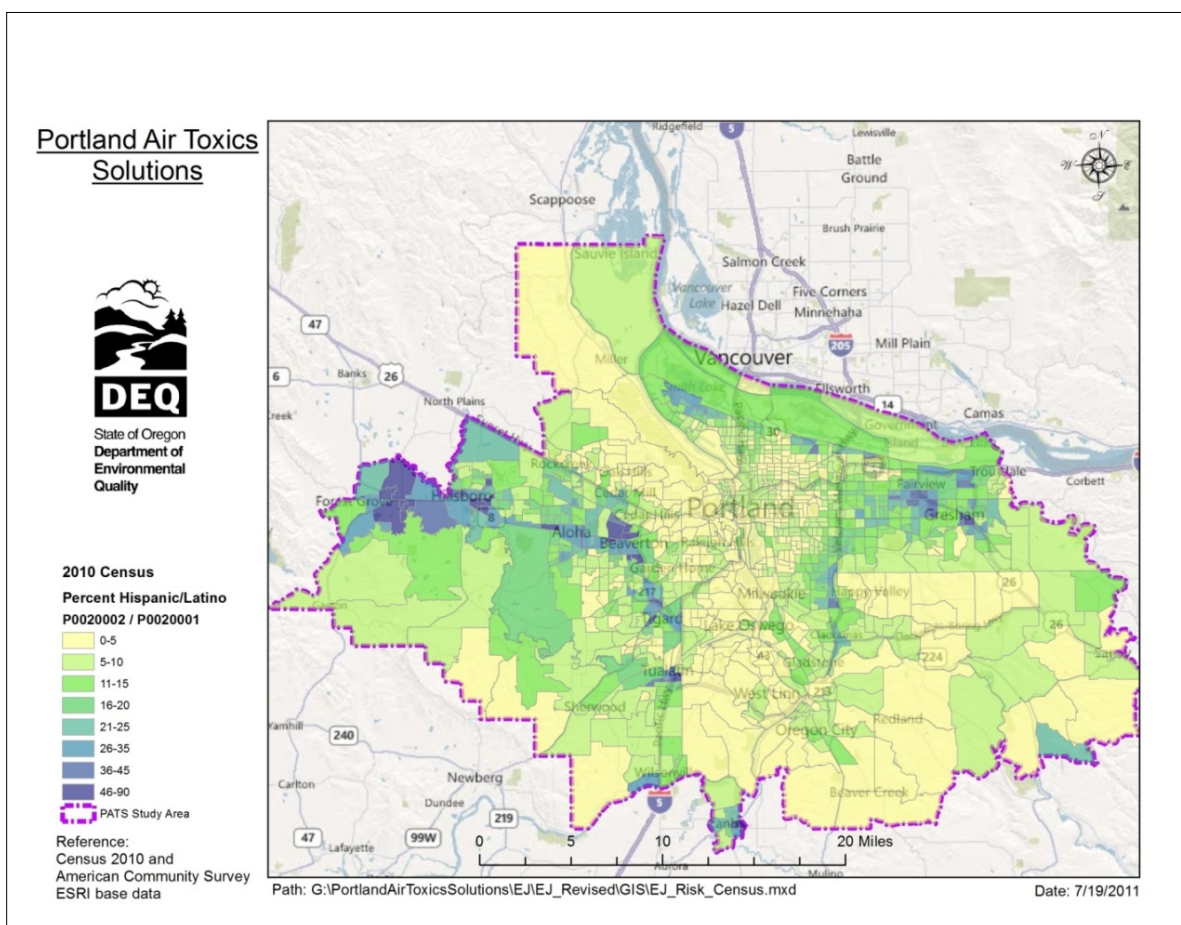


Figure 118: Percent African American/Black Population by Block Group

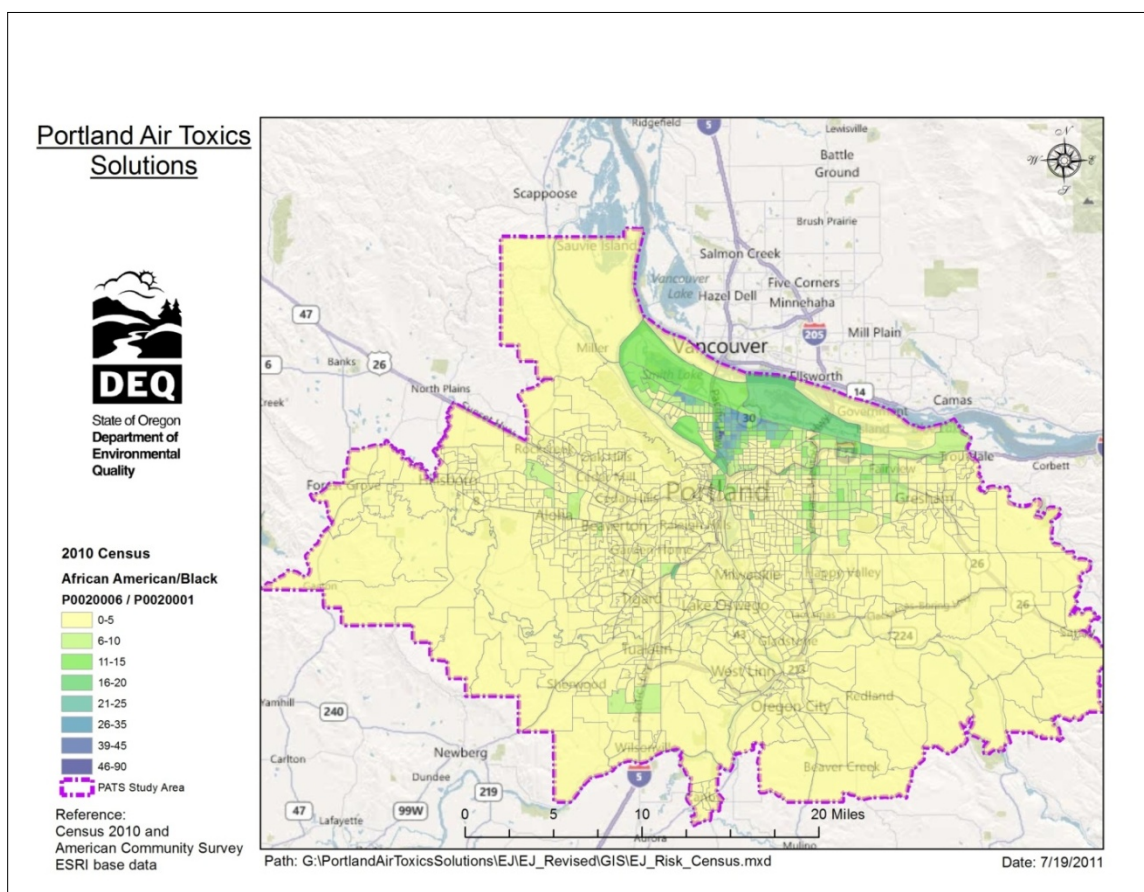


Figure 119: Percent Asian Population by Block Group

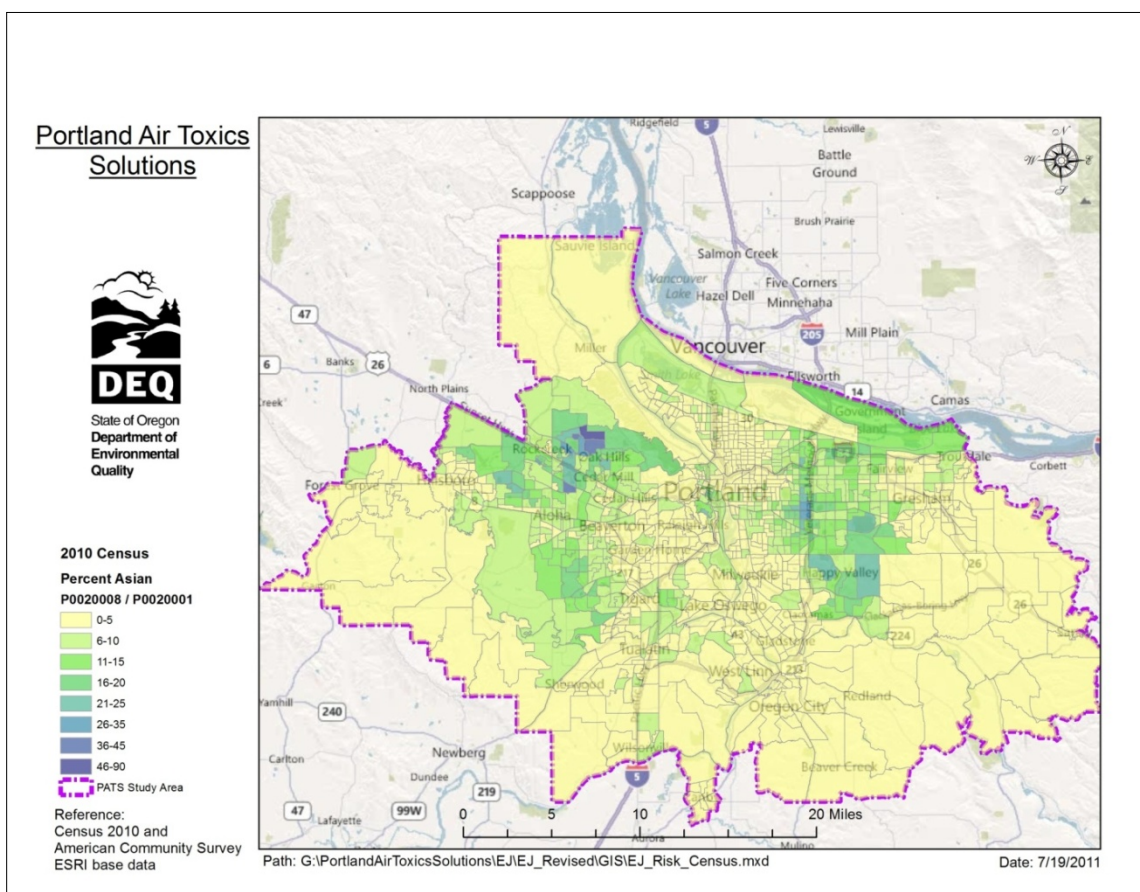


Figure 120: Percent Population below Poverty by Block Group

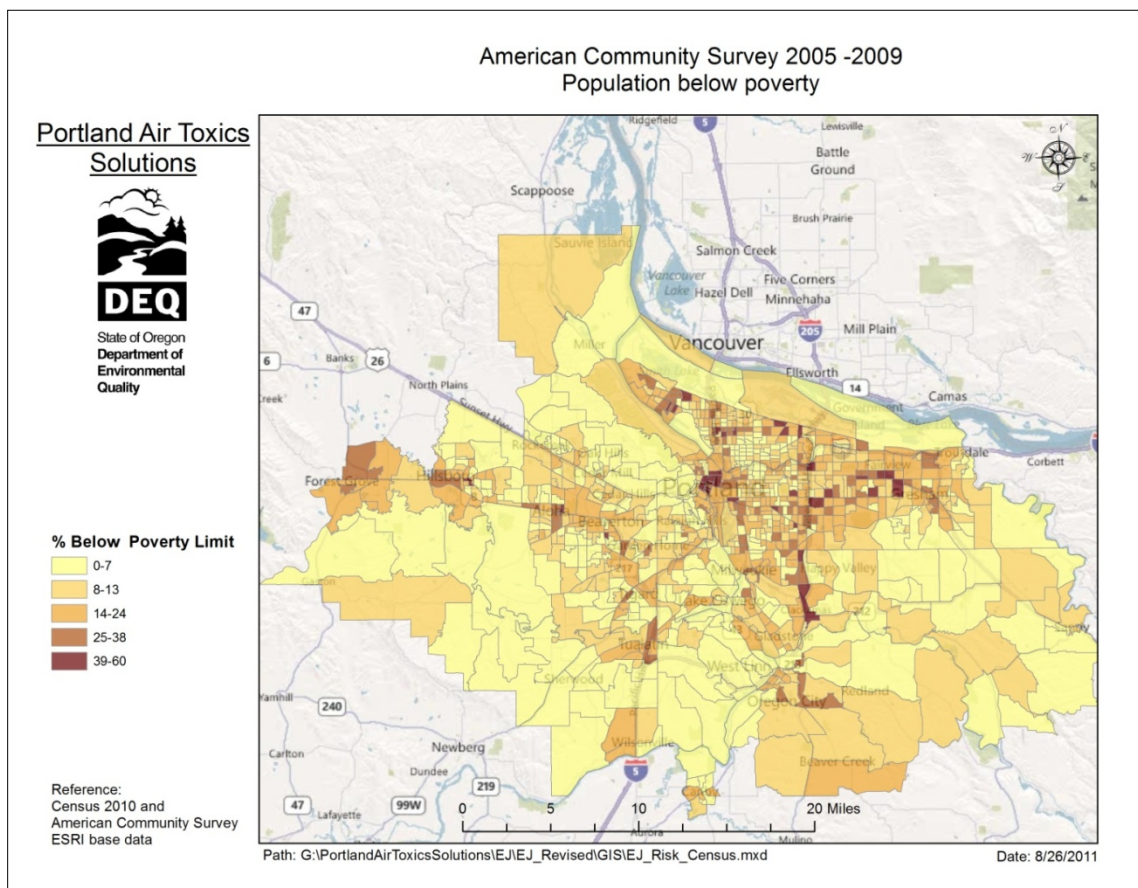
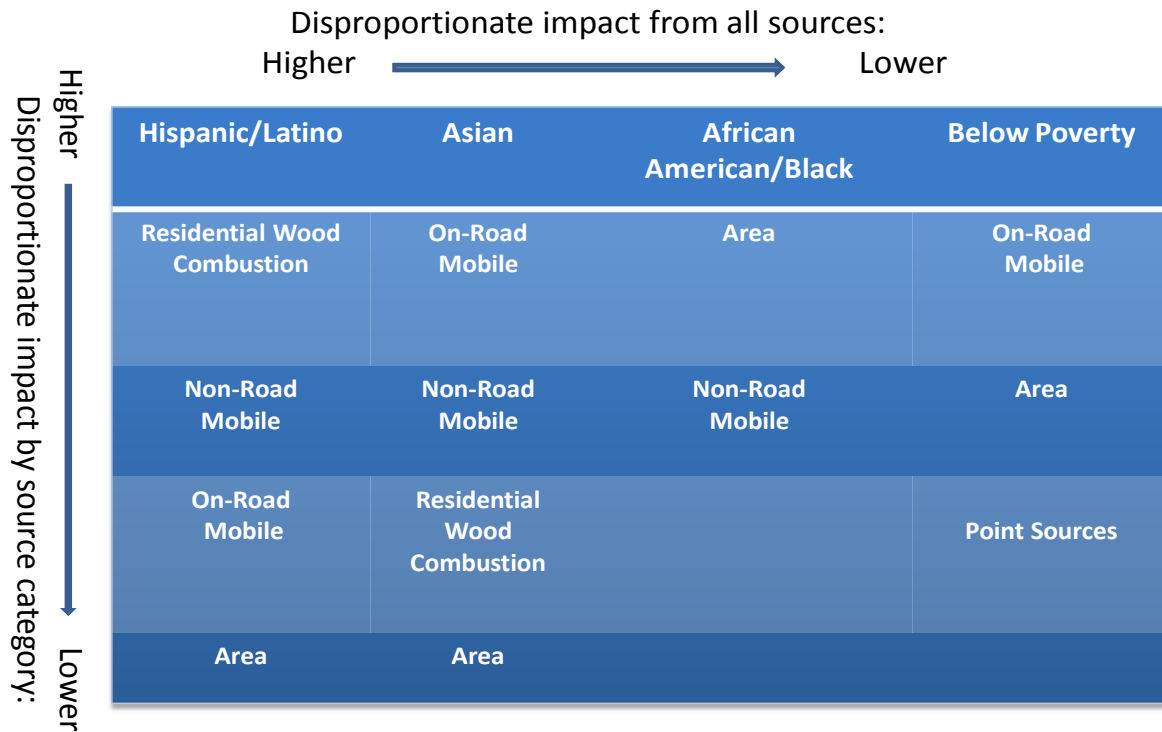


Figure 121 summarizes DEQ's findings from the multivariate regression modeling by source category. Residential wood combustion is the most significant source category affecting Hispanic/Latino population, while African American/Black populations tend to live in areas with least wood smoke. The most significant source category for African American/Black populations is area other, which includes all area sources except residential wood combustion. Asian populations are impacted mostly by on-road and non-road mobile categories. The impact decreases from left to right for all sources (e.g. the highest impact is associated with Hispanic/Latino and lowest with Below Poverty), and from top to bottom for source categories (e.g. residential wood combustion has the highest impact on Hispanic/Latino while area other sources have the least).

Figure 121: Summary findings from multivariate regression models



33

The multivariate regression analysis was the most sophisticated of the analytical approaches used in the environmental justice analysis. It produced statistically significant results that support earlier findings of disparate impacts using visual inspection, cumulative distribution and analysis in high minority and low income areas. All methods taken together confirm that there are disproportionate impacts from air toxics in minority and poor populations in the PATS study area. The regression analysis provides more detail by showing that different populations are affected differently by various sources of pollution. This information can be used to better understand and communicate public health risks as well as to target emission reductions.