

# METHODOLOGY OF DEMOGRAPHIC MULTIPLIERS FOR THE DVRPC REGION

August 6, 2018 updated



## Table of Contents

1. Background.....	3
2. Methodology .....	4
3. List of Multipliers and Summary Statistics.....	6
4. Housing Configurations and Samples.....	8
5. Geographical Units.....	9
6. Longitudinal Analysis .....	10
6. Interpreting Multiplier Results .....	11
7. Recommendations for Further Analysis.....	13
Appendix A – Geographic Change in PUMAs and Longitudinal Analysis: Crosswalk Methodology .....	15

# 1. BACKGROUND

The Delaware Valley Regional Planning Commission (DVRPC) is the federally designated Metropolitan Planning Organization for the nine-county Greater Philadelphia Region (or “DVRPC Region”): Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties in Pennsylvania, and Burlington, Camden, Gloucester, and Mercer Counties in New Jersey.

DVRPC is currently conducting an ongoing study of the community impacts of higher density housing in the region. As part of this work, DVRPC hired Econsult Solutions, Inc. (ESI) to produce demographic multipliers and related demographic statistics for multifamily units in the Greater Philadelphia Region. The multipliers and statistics were produced for seven geographies, detailed in Section 5.

A residential demographic multiplier is the average ratio of a demographic measure per household or per occupied housing unit. Common multipliers include average household size, the number of school-age children, and age cohorts by housing units. Similarly, demographic statistics estimate the distribution of demographic groups by housing type. Demographic groups can be analyzed by numerous variables including race and ethnicity, occupation, and income level.

This memo details the methodology used to develop the demographic multipliers and summary statistics for seven geographies in the DVRPC region. In addition, the report details instructions on how to interpret the multiplier and statistical tables that accompany this document.

Our findings include:

- Owner-occupied 3-bedroom average household size dropped significantly from 2011 (2.46) to 2016 (1.97)
- Average household size is higher for renter-occupied than owner-occupied for almost all housing configuration
- School Age Children (SAC) impacts are substantially higher in renter-occupied housing than in owner-occupied housing
- Vehicle ownership is down across most geographies from 2011 to 2016

## 2. METHODOLOGY

As noted, demographic multipliers are measured on a per-household or per-housing unit level. The demographic impact of a residential development is dependent on the mix of housing structures (for example, single-family detached, townhome, multifamily), size (measured by number of bedrooms), and tenure (owner- or renter-occupied).

For the purpose of DVRPC's ongoing study on multifamily development trends, this report and accompanying tables provide demographic multipliers and summary statistics for owner- and renter-occupied multifamily housing. In this report, we define multifamily housing as a structure with five or more units. This definition adheres to the technical documentation and data dictionary of the American Community Survey (ACS) Public Use Microdata Sample (PUMS). This operational definition captures the less precise but common term of "higher density housing." Below, we detail the methodology used to produce these demographic multipliers and statistical summaries for multifamily housing in the Greater Philadelphia Region.

### Data Source – ACS PUMS

We generated the demographic multipliers and summary statistics using data derived from the 2007-2011 and 2012-2016 5-Year American Community Survey (ACS) Public Use Microdata Sample (PUMS) datasets. Through 2005, PUMS was released every 10 years. Since 2005, PUMS data has been reported every year through the ACS. PUMS data includes full housing structure, size, and tenure data. This data is collected through sample surveys on individual questionnaires through a subsample of housing units. When housing unit, household, and individual data are combined on a per-unit basis, researchers can generate demographic multipliers for specific housing configurations and household groups.

The 2007-2011 and 2012-2016 PUMS dataset is a universal dataset covering every county in the United States. Data is reported at the Public Use Microdata Area (PUMA), geographies of at least 100,000 people that are nested within states or equivalent entities. States are able to delineate PUMAs within their borders, or use PUMA Criteria provided by the Census Bureau. In Pennsylvania and New Jersey, PUMAs are delineated at the county level. The list of PUMAs included in this analysis can be found in Excel document that accompanies this report.

### Historical Development of Demographic Multipliers

PUMS was the major data source used by Burchell and Listokin in their pioneering development of demographic multipliers. Their initial multipliers included 19 housing configurations, calculated for nine regional subdivisions. They restricted their analysis to units constructed in the past 10 years. In 2006, Burchell, Listokin, and Dolphin produced a set of multipliers for the 50 states and Washington, DC. These updated multipliers calculated average household size and school-age children using 2000 census PUMS data. That same year, Listokin produced similar multipliers for three sub-state regions in New Jersey.

The methodology employed in this analysis is an updated version of the multipliers, using the most recently available data. The 2012-2016 5-Year dataset was released in January 2018. It was selected because it is the most up-to-date, publicly available data from the US Census Bureau. The non-overlapping 2007-2011 dataset provides a longitudinal comparison for how demographic multipliers and summary statistics in the geography have changed over time.

### Validity of Estimates and Minimum Sample Size:

ACS PUMS data is collected from one percent of households annually, creating a five percent pooled sample for five-year PUMS. The discontinued, pre-2005 PUMS data provided a 15 percent sample. The change in PUMS sampling enables the analysis of more recent data, but produces sample size issues that can impact statistical validity. The sample size issue for new units is further impacted by the 2008 economic recession, which significantly reduced the number of new multifamily units built for more than five years after the crash.<sup>1</sup>

Our research has concluded that a minimum sample size of 36 unweighted observations is required in each housing configuration to ensure the reliability of the estimated multiplier.<sup>2</sup> In order to address the sample size issue, we use a new mover sample. We have found that the new mover sample has, on average, four times the sample size of the recently-built unit sample and the results are comparable to those generated from the recently built unit sample. We therefore produce the new mover multipliers and summary statistics in seven geographies, determined in collaboration with DVRPC. The seven geographies are detailed in Section 5.

---

<sup>1</sup> US Census, New Privately Owned Housing Units Completed: Annual Data, [www.census.gov](http://www.census.gov). In some situations commonly for units of 4 or more bedrooms, age-differentiated multipliers may not be reliable even if the sample size is larger than 36. In the two accompanying Excel files, we remove outputs and leave them blank when the statistical validity is in question.

<sup>2</sup> For a more detailed discussion of demographic multiplier methodology, see: Wong, et al. "Residential Demographic Multipliers: Using ACS PUMS Records to Estimate Housing Development Impacts" *Cityscape: A Journal of Policy Development and Research*, 19(3): 415-27.

### 3. LIST OF MULTIPLIERS AND SUMMARY STATISTICS

As noted, ESI worked closely with DVRPC to determine the demographic multipliers and statistics analyzed for this report. In total, three multipliers and nine summary statistics were produced for seven levels of geographic analysis (Tables 1 and 2).

**Table 1. Demographic Multipliers**

Multipliers	Specifications	PUMS Variable
Average Household Size	No differentiation	AGEP
School-Age Children	5-10	AGEP
	11-13	
	14-17	
Vehicles per Household	No differentiation	VEH

**Table 2. Summary Statistics**

Categories	Specifications	PUMS Variable
Age Cohorts	0-4	AGEP
	5-17	
	18-24	
	25-34	
	35-54	
	55-64	
	65+	
Educational Attainment (population 25+)	Less than high school graduate	SCHL
	High school graduate	
	Some college or Associate's degree	
	Bachelor's degree or higher	
Means of Commute (population 16+)	Public transportation (excluding taxicab)	JWTR
	Taxicab	
	Biking	
	Walking	
	Working from home	
	Car, truck, or van	
	Other	
	Not working, or no answer	
Commuting Time (population 16+)	Less than 30 minutes	JWMNP
	30 to 59 minutes	
	60 or more minutes	
Income	Median household income	HINCP
	Per capita household income	

**Table 3. Summary Statistics (Continued)**

Categories	Specifications	PUMS Variable
Occupation (population 16+)	Management, Business, Finance	OCCP
	Engineering, Computer, Science	
	Social Work, Law, Education	
	Entertainment	
	Health Care	
	Service	
	Sales & Office	
	Agriculture, Construction, Production, Repair	
	Transportation	
	Unemployed	
Race	White alone	RAC1P
	Black or African-American alone	
	American Indian and Alaskan Native alone	
	Asian, Native Hawaiian, and Other Pacific alone	
	Some other race alone	
Two or more races		
Hispanic Origin	Not Hispanic or Latino	HISP
	Hispanic or Latino	
Household Type	Living Alone	HHT
	Married Couple	
	Not Living Alone	
	Other Family (Presence of other family, excluding married couples. Defined by ACS as presence of other family and either "Male Householder, No Wife Present" or "Female Householder, No Husband present.")	

## 4. HOUSING CONFIGURATIONS AND SAMPLES

### Housing Configurations

This project focuses on occupied multifamily units, the type of housing configuration associated with higher density development. The PUMS variable BLD (units in structure) classifies each occupied housing unit as single-family detached, single-family attached, and various types of multifamily units. Traditionally, multifamily units are further grouped into two types by the number of units in the structure: two to four units, and five or more units. As noted, this project analyzes units in multifamily structures with five or more units to approximate high density housing.

We used the ACS variable BDSP (number of bedrooms) to categorize units by number of bedrooms: studio or one-bedroom, two-bedroom, and three-bedroom. Units with four or more bedrooms were excluded due to sample size. We used the PUMS variable TEN (housing tenure) to differentiate owner- and renter-occupied units because the majority of multifamily units in the DVRPC region are renter-occupied, typically rental apartments. Three-bedroom owner-occupied units only had a sufficient sample size at the nine-county region level. One-bedroom or studio units in Growing Suburbs also lacked a sufficient sample size for owner-occupied units.

### Movers Samples

As noted, the recently built unit sample has traditionally been used to generate multipliers due to its relevancy to units constructed in the near future. However as detailed above, this sample has significant sample size issues. Reliable estimates are only available for the most popular housing configurations at the county or multi-county level. We therefore calculated the multipliers and summary statistics using the new mover sample to ensure adequate sample size.

The mover sample was developed by using PUMS variable MV, which indicates when the current householders moved into the unit. New movers are categorized as those who moved into their current unit within four years prior to the PUMS survey. In this analysis, the new movers sample approximates households who moved into their unit between 2009 and 2016 for the 2016 multipliers and those who moved between 2004 and 2011 for the 2011 multipliers.<sup>3</sup>

---

<sup>3</sup> Due to the wording of the MV variable in the ACS PUMS data, the exact years included is imprecise. Respondents are asked whether they moved into their unit within the past four years, which can be interpreted in different ways for respondents. For example, if a family moved into a unit in January 2012 and completed the ACS survey in April 2016, they could count 2012 as “within four years” by the calendar year, or more than four years, as the move date is four years and three months prior. Therefore, the MV variable creates an approximate, but not precise time period for both the 2016 and 2011 analyses.

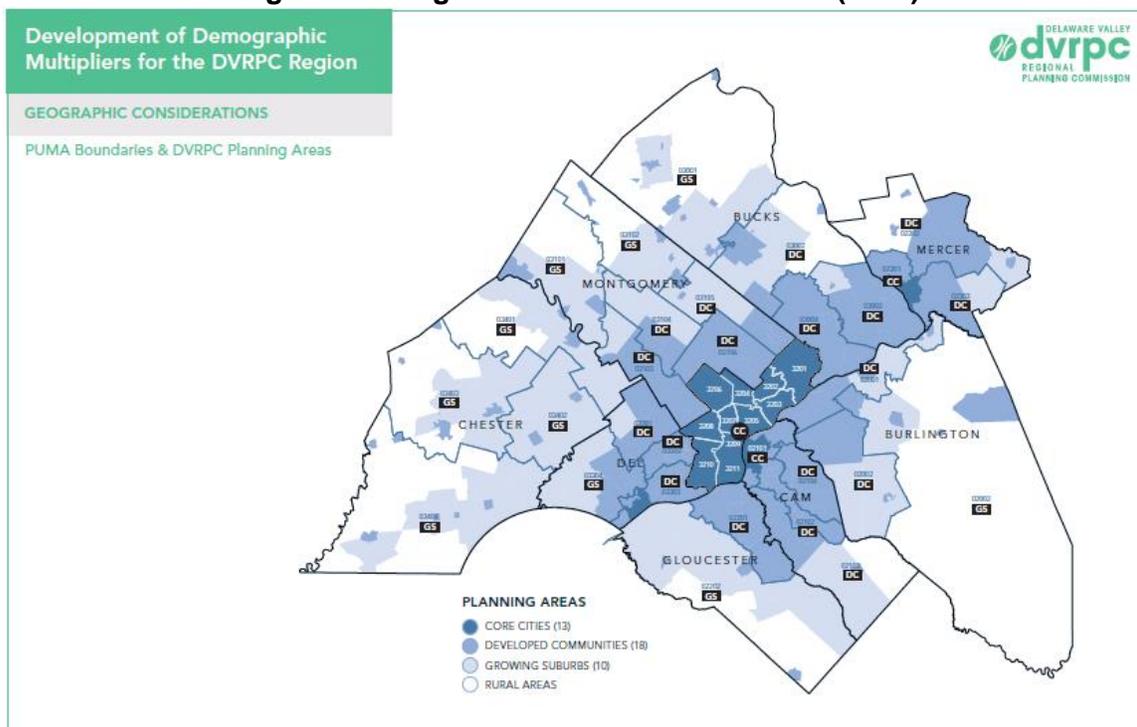
## 5. GEOGRAPHICAL UNITS

Based on conversations with DVRPC, multipliers and summary statistics in this analysis are reported for seven geographies, based on 2010 PUMAs<sup>4</sup>:

- The aggregate nine-county DVRPC region
- Suburban Pennsylvania (four Pennsylvania counties, excluding Philadelphia)
- New Jersey (four New Jersey Counties, including the City of Camden and Trenton)
- Philadelphia County
- Aggregates by DVRPC Planning Area
  - Core Cities
  - Developed Communities
  - Growing Suburbs (includes Rural Areas)

Each PUMA was categorized and aggregated into one of three DVRPC Planning Areas: Core Cities, Developed Communities, or Growing Suburbs. ESI conducted this PUMA aggregation based on conversations with DVRPC and the overlay of multifamily land use data from CoStar GIS, PUMA boundaries, and Planning Areas. How each PUMA is categorized is illustrated in Figure 1. Mover samples were then calculated by housing configuration for each of the seven geographies.

**Figure 1. Categorization of DVRPC PUMAs (2010)**



<sup>4</sup> PUMA boundaries changed between the 2007-2011 and 2012-2016, based on the redrawing of PUMA boundaries every 10 years following the Census. The 2007-2011 data uses the 2000 PUMAs and the 2012-2016 data uses the 2010 PUMAs. Details on how we addressed this geographic change is detailed in Appendix A.

## 6. LONGITUDINAL ANALYSIS

As discussed above, one purpose of this project is to identify changes in multifamily household characteristics over time. In order to evaluate how demographic multipliers and statistics in the DVRPC region have changed over time, we calculated the same set of multipliers and statistics for the 2007-2011 and 2012-2016 PUMS datasets. The 2011 and 2016 tables are presented in the same tabs of the accompanying Excel document in order to enable easy comparisons. The two sets of results are from discrete or non-overlapping 5-Year ACS PUMS in accordance to Census Bureau's recommendations for longitudinal analysis.<sup>5</sup>

Most of the multiplier and statistical comparison between 2011 and 2016 results are straightforward. Two cautions should be made. First, the results are based on sample estimation, so a minor difference in numerical value may not necessarily indicate a statistically significant change over time. Second, the income reported is inflation-adjusted. Multiyear ACS PUMS has a variable to convert any monetary value from the year of the survey conducted to the latest year of surveying. The income statistics for both the 2011 and the 2016 tables are both reported in 2016 dollars.

---

<sup>5</sup> The Bureau always advises against using overlapping multiyear ACS datasets for longitudinal comparison. The primary reason is that overlapping datasets or samples double-counts and make statistical test and the calculation of margin of error very difficult.

## 6. INTERPRETING MULTIPLIER RESULTS

### Demographic Multipliers

Demographic multipliers are estimated by dividing the weighted variables – the total number of occupants, school-age children, and vehicles – by the weighted number of households. Multipliers estimate the average impact of each category by housing configuration and tenure. For example, in 2016 the overall average household size for a two-bedroom, owner-occupied unit in the nine-county region is 1.66 people (Table 3). For renter-occupied two-bedroom units, the average household size in the same geography is 2.30 persons. The multipliers can be used to estimate the population, school-age children, and vehicle impacts of new development.

**Table 4. Average Household Size Demographic Multiplier 2016**

Average Household Size	2016							
	OWNER-OCCUPIED				RENTER-OCCUPIED			
	All	1 bedroom or studio	2 bedrooms	3 bedrooms	All	1 bedroom or Studio	2 bedrooms	3 bedrooms
The aggregate 9-county DVRPC region	1.57	1.29	1.66	1.97	1.74	1.33	2.30	3.28
Suburban Pennsylvania	1.60	1.29	1.61		1.78	1.34	2.29	3.49
New Jersey	1.67	1.27	1.85		1.88	1.39	2.45	3.53
Philadelphia County	1.48	1.30	1.57		1.59	1.29	2.14	2.82
Core Cities	1.51	1.30	1.64		1.61	1.28	2.21	2.94
Developed Communities	1.62	1.30	1.70		1.83	1.40	2.35	3.37
Growing Suburbs	1.57		1.58		1.79	1.30	2.30	3.72

### Summary Statistics

In addition to demographic multipliers, we calculated the summary statistics detailed above by housing configuration and tenure. These are calculated by using weighted estimates from the PUMS data and show the distributions across each housing configuration and tenure. The summary statistics can be used to understand the demographics of particular housing types. For example, 29.3 percent of owner-occupied one-bedroom or studio households in New Jersey are occupied by households of Hispanic origin, compared to 5.4 percent of the same housing type in Suburban Pennsylvania. The full set of multipliers and statistics can be found in the accompanying Excel document.

**Table 5. Summary Statistics for Hispanic Origin 2016**

		2016								
		OWNER-OCCUPIED			RENTER-OCCUPIED					
	Ethnicity	All	1 bedroom or studio	2 bedrooms	3 bedrooms	All	1 bedroom or studio	2 bedrooms	3 bedrooms	Total
The aggregate 9-county DVRPC region	Hispanic	5.1%	8.6%	4.0%	2.8%	10.7%	8.5%	13.3%	8.9%	10.3%
	Non-Hispanic	94.9%	91.4%	96.0%	97.2%	89.3%	91.5%	86.7%	91.1%	89.7%
Suburban Pennsylvania	Hispanic	2.6%	5.4%	2.5%		8.6%	4.6%	12.3%	7.1%	8.2%
	Non-Hispanic	97.4%	94.6%	97.5%		91.4%	95.4%	87.7%	92.9%	91.8%
New Jersey	Hispanic	10.2%	29.3%	6.8%		16.4%	13.4%	19.4%	15.2%	16.1%
	Non-Hispanic	89.8%	70.7%	93.2%		83.6%	86.6%	80.6%	84.8%	83.9%
Philadelphia County	Hispanic	4.8%	4.8%	3.5%		8.2%	9.0%	7.6%	5.2%	7.9%
	Non-Hispanic	95.2%	95.2%	96.5%		91.8%	91.0%	92.4%	94.8%	92.1%
Core Cities	Hispanic	4.8%	5.6%	3.0%		9.6%	10.3%	9.2%	7.8%	9.3%
	Non-Hispanic	95.2%	94.4%	97.0%		90.4%	89.7%	90.8%	92.2%	90.7%
Developed Communities	Hispanic	6.8%	14.6%	5.8%		11.1%	7.4%	14.5%	11.1%	10.8%
	Non-Hispanic	93.2%	85.4%	94.2%		88.9%	92.6%	85.5%	88.9%	89.2%
Growing Suburbs	Hispanic	0.3%		0.0%		11.7%	6.9%	16.6%	6.3%	11.1%
	Non-Hispanic	99.7%		100.0%		88.3%	93.1%	83.4%	93.7%	88.9%

## 7. RECOMMENDATIONS FOR FURTHER ANALYSIS

This report details our initial work generating demographic multipliers and summary statistics for higher density housing in the Greater Philadelphia region. In the proposal we submitted to DVRPC in response to the April 2018 demographic multiplier RFP, we discussed areas where ESI could provide further advising services for DVRPC. In particular:

Other samples for specialized housing such as condominium, affordable housing, and TOD units usually suffer from more severe sample size issues and require more research beyond the resources in this study. The project team will pay attention to such possibilities and report back to DVRPC project manager for possible study in Phase 2. [Page 13 Technical Proposal]

During the study, the project team will identify potential innovative alternatives and methods that may be useful for Phase 2 considerations. Efforts will be devoted to identify additional multipliers and specialized housing relevant to the larger Community Impacts of Higher Density Development Study. [Page 16]

Based on the analysis produced in accordance with this project, we recommend further analysis on the following items:

### Aging Effect of “New” Units

DVRPC and its planning partners are interested in quantifying demographic changes and community impacts of multifamily units over time. The comparison of 2011 and 2016 results partly answers this question, but a more nuanced estimate is available for some housing configurations. The PUMS variable YBL (year structure first built) can be used to divide the 2016 five-year sample into newly built and older built units by choosing a year of demarcation. Based on our initial conversations with DVRPC, we did not recommend this analysis in this round of multiplier generation due to sample size concern and limited project resources.

However, through the work completed for this report, we identified that one-bedroom and studio, and two-bedroom renter-occupied units have sufficient sample sizes for this analysis. Although this analysis would exclude owner-occupied and three-bedroom renter occupied units, it would provide estimates for the housing configurations that constitute nearly 90 percent of multifamily housing in the DVRPC region. By calculating multipliers by building year, we can produce a “new unit sample” and “older unit sample” to create a more precise picture of how demographics differ between newer and older multifamily housing units.

### Expanded List of Demographics and Housing Configurations

In this analysis, we produced estimates for three demographic multipliers and nine summary statistics. Dependent on DVRPC’s needs, we can produce additional multipliers and statistics including: housing conditions, time of departure for work, location of previous residence (domestic migration), retirement income, public vs. private school attendance, and Medicaid and other public assistance recipients. We are available to

discuss with DVRPC its needs for further analysis. Based on the results from the initial 12 analyses, we recommend a minimum analysis of work departure time, retirement income, and domestic migration.

In addition, we can filter average household size and other demographics by types of housing configurations, including condominiums, foreign-born householders, and specific ranges of rent-to-household income, and gross monthly rent. Due to sample size issues, this filtered analysis of housing configurations would be reliable only for one- and two-bedroom renter-occupied. However, as detailed, these two configurations represent the vast majority of multifamily units in the DVRPC region.

### Specialized Housing Samples

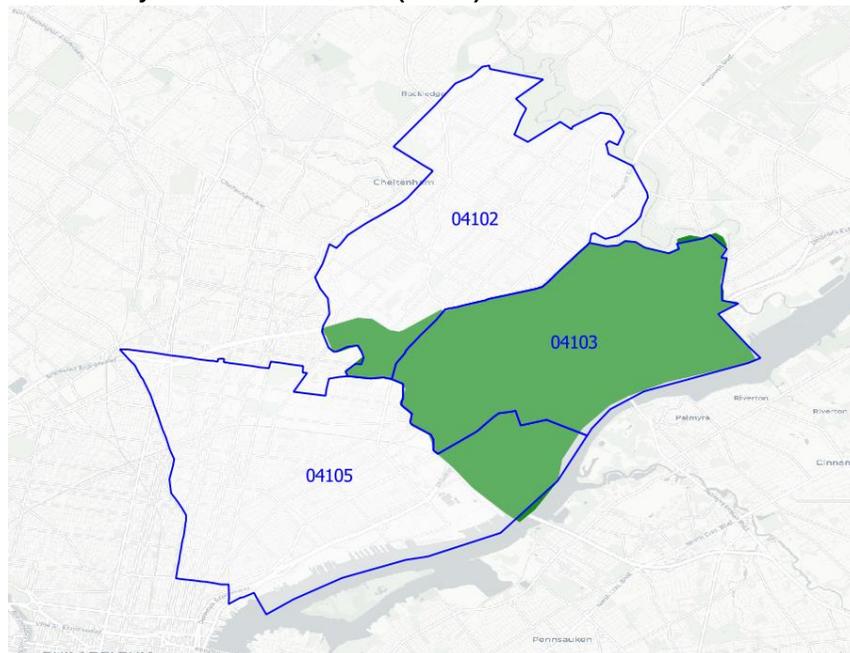
Beyond filtered configurations directly enabled by PUMS variables, ESI is available to develop proxy estimates for specialized housing types, including age-restricted development, transit-oriented development, and affordable housing. Our project team member, Professor David Listokin, has previously discussed the potential for examining demographic multipliers for specialized housing. In particular, we recommend analyzing school impacts by household income level.

## APPENDIX A – GEOGRAPHIC CHANGE IN PUMAS AND LONGITUDINAL ANALYSIS: CROSSWALK METHODOLOGY

The analysis compares 2007-2011 American Community Survey (ACS) data with 39 PUMAs to 2012-2016 ACS data with 41 PUMAs, each of which was categorized as a Core City, Developing Communities, or Growing Suburbs. DVRPC categorized the PUMAs using the 2010 PUMA boundaries in Pennsylvania and New Jersey. However, the 2007-2011 ACS data relies on the 2000 PUMA boundaries. 2010 and 2000 PUMAs are not the same spatial units and the codes are typically not the same. To conform to the requirement of a minimum of 100,000 persons, PUMA boundaries are modified after the population count is available, usually two years after the decennial census. In order to make an accurate comparison between the two data sets, it is necessary to match the 2010 PUMAs to 2000 PUMAs using the crosswalk generated by Missouri Census Data Center. Missouri Census Data Center provides a crosswalk to generate allocation factors between these the two sets of PUMAs.<sup>6</sup>

When the forward and backward allocation factors are close to 100 percent, a simple conversion works reasonably well. However, some PUMAs in 2000 changed significantly by 2010. In these cases, ESI determined which 2000 PUMA, or multiple 2000 PUMAs, held the largest population-weighted allocation factor(s) within each of the 2010 PUMAs. For example, 2010 PUMA 03203 (Philadelphia City (Near Northeast-East)) overlapped with three 2000 PUMAs: 04102, 04103, and 04105. The allocation factor for 04102 is 0.031, the allocation factor for 04103 is 0.919, and the allocation factor for 04105 is 0.050. As such, 2000 PUMA 04103 most appropriately matches the area needed to analyze the 2007-2011 ACS data (see Figure 2, 2010 PUMA 03203 in green). This enables the most accurate longitudinal analysis given the changes in PUMA boundaries.

**Figure 1. Overlay of 2010 PUMA 03203 (Green) Overlaid on 2000 PUMA Boundaries**



<sup>6</sup> Missouri Census Data Center. *MABLE/Geocorr14: Geographic Correspondence Engine*. <<http://mcdc.missouri.edu/websas/geocorr14.html>>