



New York Metropolitan Transportation Council

NYMTC 2050
Socioeconomic and
Demographic (SED) Forecast

Zonal Allocation Methodology

Technical Memorandum | Task 6

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Disclaimer

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Table of Contents

1.0	INTRODUCTION.....	1
2.0	NYC ALLOCATION PROCESS	3
2.1	Overview.....	3
2.2	TAZ Allocation of Housing and Population Variables	7
2.2.1	NYC Department of Buildings Data	7
2.2.2	TAZ Allocation of Housing Units.....	8
2.2.3	Allocation of Housing Units: 2010-2020.....	9
2.2.4	Allocation of Housing Units: 2020 to 2050	13
2.2.5	TAZ Allocation of Population Variables	13
2.2.6	Projections at the TAZ Level	14
2.2.7	TAZ Allocation of Group Quarters Population	15
2.3	Allocation of K-12 and University Enrollment.....	16
2.3.1	K-12 Enrollment	16
2.3.2	University Enrollment.....	18
2.4	Employed Civilian Labor Force	21
2.5	Allocation of Average Household Income	21
2.6	Allocation of Employment	21
2.6.1	2010 Allocation of Total, Office and Retail Employment	21
2.6.2	2012 and 2015 Allocation of Total, Retail, and Office Employment	27
2.6.3	Inputs to the 2020 and 2050 Employment Allocation	28
2.6.4	2020 and 2050 Total and Office Employment Allocation	29
2.6.5	2020 and 2050 Retail Employment Allocation	30
2.6.6	Special TAZs.....	31
2.7	Median Earnings per Worker.....	31
3.0	NON-NYC ALLOCATION PROCESS.....	32
3.1	Overview.....	32
3.2	Comparison to NYMTC's 2040 SED Zonal Allocation Process	33
3.3	2050 Zonal Allocation Process Details.....	34
3.3.1	County Level Forecasts, Base Year Allocation and Future Year Controls	34
3.3.2	Existing Land Use	34
3.3.3	Developable Space	41
3.3.4	Planned Projects	45
3.3.5	Allocation Factors.....	46

3.3.6	ZAP Model Growth Fitting.....	54
3.3.7	Allocation of Employment Variables	57
3.3.8	Allocation of Households and Population Variables.....	57
3.3.9	K-12 School Enrollment.....	58
3.3.10	University Enrollments	60
3.3.11	Average Household Income.....	63
3.3.12	Median Earnings per Worker	63

List of Tables

Table 1-1.	Zonal Allocation Variables	2
Table 2-1.	CofO Completions	11
Table 2-2.	Group Quarters Population	16
Table 2-3.	K-12 Enrollment.....	18
Table 2-4.	University Enrollment.....	20
Table 2-5.	Differences between CTPP and LEHD Data	22
Table 2-6.	NAICS Codes	25
Table 2-7.	Jobs to Workers Comparison	27
Table 2-8.	Commercial Square Footage to Worker Conversion.....	29
Table 2-9.	Borough Multiplier and General Growth Component – Total & Office Employment.....	29
Table 2-10.	Borough Multiplier and General Growth Component Retail Employment.....	30
Table 3-1.	New York State Tax Assessor Codes (General Category)	36
Table 3-2.	NLCD & LBG Land Use Categories	38
Table 3-3.	SWRPA & LBG Land Use Categories	39
Table 3-4.	Summary of Land Use Designation in Square Miles, (Constrained Land %)	41
Table 3-5.	Place Typology Definitions & Corresponding Future Development Density Increases	42
Table 3-6.	Developable Area Estimate (Square Miles).....	44
Table 3-7.	Housing Vacancy Rate Assumptions & Impacts on Developable Space.....	45
Table 3-8.	Commercial Space to Employment Conversion Factors	46
Table 3-9.	Development Inventory Housing Units and Total Employment	46
Table 3-10.	Sample Calculation of Highway Proximity Allocation Factor (Putnam County).....	50
Table 3-11.	Sample Calculation of Highway Accessibility Allocation Factor (Ocean County)	51
Table 3-12.	Household Allocation Factor Weights.....	53
Table 3-13.	Employment Allocation Factor Weights.....	54
Table 3-14.	Weighted Allocation Factor Calculation (Putnam County)	54
Table 3-15.	Future Development Density Assumptions by Place Typology.....	56
Table 3-16.	Historic and Projected School Enrollment.....	60

List of Figures

Figure 1-1. NYMTC Region & Sub-Regional Geography	1
Figure 2-1. Borough Planner Data Processing Example	6
Figure 2-2. TAZ Allocation of Housing Units Overview.....	9
Figure 2-3. Completion Rate Calculation.....	10
Figure 2-4. Completion Rate Calculation with PUMA Estimates.....	11
Figure 2-5. Sample Bronx PUMA Population Data	13
Figure 2-6. Sample Bronx TAZs Population Data	15
Figure 2-7. K-12 Enrollment by TAZ.....	17
Figure 2-8. University Enrollment by TAZ - Overview	19
Figure 2-9. University Enrollment by TAZ - Calculations	20
Figure 2-10. Allocation of Total Employment to Census Tracts	24
Figure 2-11. Allocation of Office and Retail Employment to TAZs	26
Figure 2-12. Employment Allocation	28
Figure 3-1. Summary Overview of TAZ Allocation Process.....	32
Figure 3-2. Parcel Level Data Example.....	35
Figure 3-3. New York and New Jersey Land Use Aggregations	37
Figure 3-4. New York & New Jersey Regional Constrained Land	40
Figure 3-5. Place Typology Map	43
Figure 3-6. Housing Vacancy Rates.....	44
Figure 3-7. Examples of County Mapped Priority Growth Areas (Dutchess, Orange, Rockland).....	48
Figure 3-8. Example of Major Highway Corridors	49
Figure 3-9. Sample Correlations of Household Price & Zonal Distribution	52
Figure 3-10. Zonal Allocation Process Overview	55
Figure 3-11. K-12 Enrollment by TAZ.....	59

1.0 INTRODUCTION

The New York Metropolitan Transportation Council (NYMTC) is a regional council of governments (COG) that is the metropolitan planning organization (MPO) for New York City, Long Island and the lower Hudson Valley. NYMTC provides a collaborative planning forum to address transportation-related issues, develop regional plans and make decisions on the use of federal transportation funds. Socioeconomic and demographic (SED) forecasts are crucial components in the development of regional transportation plans, air quality conformity analysis and decision-making on the use of these funds. In order to produce the 2050 SED forecasts, NYMTC retained the services of The Louis Berger Group (LBG), in collaboration with the New York City Department of City Planning (DCP), to create population, employment, labor force, and household forecasts for the region at the county level, and to develop allocations of the county-level SED projections down to the Transportation Analysis Zone (TAZ) level.

This technical memorandum documents details of the proposed methodology employed by the Project Team to generate the TAZ employment and population that make up the operating boundary of the New York Best Practices Model (NYBPM) as shown in Figure 1-1. Figure 1-1 shows the segmentation of the 31-County Forecast Region into five distinct subregions and provides a geographic description of the counties comprising each of the five subregions:

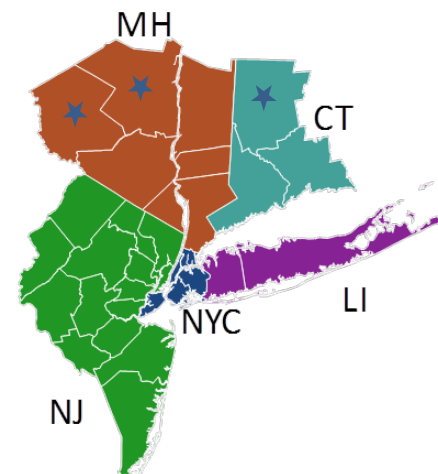
- New York City (NYC)
- Long Island (LI)
- Mid-Hudson (MH)
- New Jersey (NJ)
- Connecticut (CT)

TAZ allocations of the county-level variables were not performed for three of the counties in the 31-County Region as highlighted by the asterisks in Figure 1-1, as these counties are not part of the NYBPM region.

FIGURE 1-1. NYMTC REGION & SUB-REGIONAL GEOGRAPHY

New York City	Long Island	Mid-Hudson	New Jersey	Connecticut
Bronx	Nassau	Dutchess	Bergen	Fairfield
Kings	Suffolk	Orange	Essex	Litchfield★
New York		Putnam	Hudson	New Haven
Queens		Rockland	Hunterdon	
Richmond		Sullivan★	Mercer	
		Ulster★	Middlesex	
		Westchester	Monmouth	
			Morris	
			Ocean	
			Passaic	
			Somerset	
			Sussex	
			Union	
			Warren	

★ TAZ allocation not conducted



The processes highlighted in this technical memorandum allocated 16 variables to each TAZ as defined by NYMTC's Best Practices Model (BPM). The list of 16 variables included in this allocation is presented

in Table 1-1. The table also indicates the variables which were down-allocated from a county control total.

TABLE 1-1. ZONAL ALLOCATION VARIABLES

	Variables	Description	County Control
1.	TOTPOP	Total Population (pulled from Census 2010; also, should be equal to the sum of HHPOP and GQPOP)	Yes
2.	HHPOP	Household Population (pulled from Census 2010)	Yes
3.	GQPOP	Group Quarters Population (pulled from Census 2010; also, should be equal to the sum of GQPOPINS, GQPOPSTR, and GQPOPOTH)	Yes
4.	GQPOPINS	Institutionalized Group Quarters Population (includes correctional, juvenile, nursing, and other institutional facilities)	No
5.	GQPOPSTR	"Homeless" Group Quarters Population (includes people living in shelters and some other noninstitutional facilities) – with no usual place of residence	No
6.	GQPOPOTH	Other Group Quarters Population (Colleges & Universities, Military, etc.)	No
7.	HHNUM	Number of Households	Yes
8.	HHSIZE	Average Household Size	No
9.	ELF	Employed Civilian Labor Force	Yes
10.	HHINCX	Average Household Income	No
11.	EMPTOT	Total Employment	Yes
12.	EMPRET	Retail Employment (NAICS:44-45)	Yes
13.	EMPOFF	Office Employment (NAICS:51, 52, 53, 54, 55, 56)	Yes
14.	EARNWORK	Earnings per Worker	No
15.	UNVENROL	University Enrollment	No
16.	K12ETOT	K-12 School Enrollment	No

Because the methodologies used to generate the underlying county forecasts in New York City (NYC) differed from those used to generate forecasts for the remaining 26 counties outside NYC, separate approaches were also used in the TAZ allocation process. The details of the allocation methodologies for both regions will be discussed separately in this Technical Memorandum.

2.0 NYC ALLOCATION PROCESS

2.1 Overview

A major input to the population and employment models consisted of analyses conducted by the Department of City Planning (DCP) borough offices. As part of DCP's work program, planners in each of DCP's five borough offices are responsible for tracking and managing projects within their respective boroughs, with each planner assigned to monitor one or more community districts. By leveraging their institutional knowledge, the project team developed a process to collect and codify data pertaining to potential changes in population and employment within site-specific geographic boundaries.

The following types of data were collected and processed for use in the population and employment model:

1. **As-of-right developments** included recently completed projects or developments planned for the near future. These are large commercial and/or residential developments that are not captured in other available data sources since they don't require additional permits or variances beyond those required by the NYC Department of Buildings (DOB). For residential developments, this would include sites where a developer had announced plans, but the project had not yet reached the DOB permitting process. For commercial developments, which are not represented in the DOB data, any project that had been announced or completed after 2013 was included, since 2013 was the last year of available employment data from Quarterly Census of Employment and Wages (QCEW).

As-of-right developments were generally assumed to be completed by 2020, unless borough planner input projected delays in the listed completion date.

2. **Pipeline projects** included proposals underway by private applicants or city agencies, including DCP, which required approval by the City Planning Commission or the Board of Standards and Appeals. These types of applications often entail a request for an override of a zoning district's regulations pertaining to the size and use of buildings. The Housing Pipeline database is managed by DCP and tracks the status of a large set of projects as they move through the approval process. Pipeline projects are not limited to housing developments, and may include commercial development. Projects currently in the pipeline are projected to reach completion by 2020, unless otherwise indicated by the project's lead planner.

Examples of pipeline projects can range from large actions, such as a proposed neighborhood rezoning to smaller land use changes -- for example, a property owner's request to convert a building from industrial to residential use or a request to reduce parking requirements for a planned commercial development. Construction on large public sites is also grouped in this input type, including initiatives of the New York City Housing Authority and Department of Housing Preservation and Development.

3. **Adopted rezonings** encompassed any change to the city's zoning map by the city or a private applicant that increased the maximum allowable floor area ratio (FAR) of future construction or changed permitted use regardless of FAR changes. Every rezoning is required to follow the Uniform Land Use Review Procedure (ULURP) to assess impact of the zoning change. ULURP requires a projection of potential new development that would occur as a result of the action. For most actions, anticipated increases in housing units and/or commercial square footage by type (community facility, retail, industrial, etc.) are specified in the Environmental Impact Statement (EIS) along with

completion dates. Some areas with EIS projections that were considered by planners in retrospect to be very aggressive were scaled back to keep pace with other borough projects. In these cases, it was assumed that the amount of growth in the EIS would not be reached by 2050. EISs for rezonings adopted prior to January 2013 were reevaluated and projected growth was adjusted to match recent development patterns if deemed necessary.

Rezoning areas are often described as “upzoned” or “downzoned” if the change in allowable FAR is increased or decreased, respectively. Upzoning or downzoning refers simply to the change in FAR, regardless of whether use regulations are changed, for example from commercial to mixed commercial and residential uses. For large rezonings in the database, which contain both upzoned and downzoned blocks, only upzoned blocks were geocoded and assigned the projected growth arising from the rezoning action.¹ Additionally, upzoned areas were analyzed to determine what percentage of anticipated housing units have come to fruition (based on DOB data, described below). Only the remaining, not-yet-built portion of the projected units was used as input to the population model to avoid double counting.

4. **Areas of opportunity** were defined as areas that could see future housing growth or may be rezoned in future years. They were mostly located along major thoroughfares in proximity to mass transit. While the previous three categories were more firm in their accounting of new units, there was less certainty regarding when and how many units will be developed in areas of opportunity. Nonetheless, the analysis conducted by the project team with the borough planners yielded significant insights into these areas and provided us with a basis for assigning a number of potential units that may be created in future years.

The projected development of new housing units in areas of opportunity was closely tied to the policies set forth in *Housing New York: A Five-Borough, Ten-Year Plan*. This comprehensive plan to build and preserve 200,000 affordable housing units will be accomplished in part by rezoning portions of the city where additional residential development may be accommodated. In concert with the release of the Mayor’s report, DCP has announced that it will target 15 neighborhoods for upzoning in the coming year, thereby increasing the city’s housing capacity. For the allocation of housing units to the TAZ level, it was assumed that 90 percent of proposed residential and commercial development would occur in these areas by the end of the forecast period. As of September 10th, 2015, the following neighborhoods have been undergoing rezoning studies as part of the Mayor’s Plan:

- Cromwell/ Jerome, Bronx
- East New York, Brooklyn
- East Harlem, Manhattan
- Flushing West, Queens
- Long Island City, Queens
- Stapleton, Staten Island

Other areas of opportunity ranged from large underutilized parcels that could be developed as-of-right to the expansion of existing institutions and developments. For each of the other areas of opportunity, a *likelihood score* was subjectively assigned to the project by its assigned borough

¹ In downzoned areas, current population and employment levels were held constant, as further growth was assumed to be minimal. An exception was when a pipeline project or building permit was issued in a downzoned area, and the associated growth in population or employment was accounted for in the model.

planner, with 1 defined as least likely and 5 most likely to be developed. The proportion of growth in each area of opportunity assumed to reach fruition by the end of the forecast period was tied to the *likelihood score* as follows:

Likelihood score	1	2	3	4	5
Percent completed by 2050	10%	30%	50%	70%	90%

For all projects in the four categories, the following attributes were collected:

- Project name and type
- Precise boundaries of the project area
- Lead planner responsible for tracking the project
- Tracking number, if applicable
- Total housing units added
- Commercial square footage added
- Type of commercial use(s)
- Percent of project projected to be completed by 2020
- Overall likelihood of project

For all projects in the four categories, the estimate of projected residential and commercial development was split into two time periods -- the 2015-2020 increment and the 2020-2050 increment. This split was calculated from the percent projected to be completed by 2020, as indicated by the planners. These increments were used to allocate population and employment growth to appropriate time periods, described later in this document.

Each input type was geocoded to specific project boundaries and linked to the TAZ it fell within. If one project spanned multiple TAZs, as was the case for many neighborhood-wide rezonings, projected growth was allocated to TAZs proportionally to the total upzoned area that fell within each TAZ.

To avoid double counting potential housing units, all projects in the four categories were checked against Department of Buildings (DOB) data, described below. Any completed or permitted portions of the projects present in the DOB data were subtracted from total housing units allocated to TAZs.

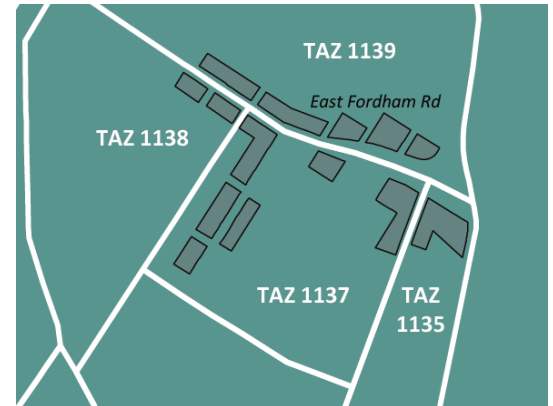
An example (Figure 2-1) of how borough planner data were processed is illustrated below. The East Fordham Road rezoning in the Bronx was approved in 2013 and planners projected both residential and commercial growth in the affected blocks as a result of the zoning change. The accompanying EIS analysis projected an additional 352 housing units and significant office square footage to be developed by 2023. Borough planner feedback indicated that 90% of this development is likely enough to be factored into the TAZ allocation based on current development trends, as seen in the first table below. The likelihood score and completion rate by 2020 were used to determine total housing units and employment for the two time increments used in the analysis, 2015-2020 and 2020-2050, shown in the second table.

The map below shows the spatial relationship between the upzoned blocks of East Fordham Road, outlined in black, and the affected TAZs, outlined in white. The total area of the rezoned blocks is 522,687 square feet, and the percent of that area that falls within each TAZ is listed in the third table. This percentage by TAZ was multiplied by the total likely growth for the project to determine the housing unit and employment growth allocated to each TAZ for both time intervals.

FIGURE 2-1. BOROUGH PLANNER DATA PROCESSING EXAMPLE

Project	Type	Likely	% Completed by 2020	Total Area
East Fordham Rd	DCP Rezoning	90%	70%	522,687

	Housing Units	Total Workers	Retail Workers	Office Workers
Total Unadjusted	352	400	0	325
Total Likely for Project	317	360	0	293
2015-2020 Amount	222	252	0	205
2020-2050 Amount	95	108	0	88



TAZ	% of Total	2015-20 Amount				2020-2050 Amount			
		Housing Units	Total Workers	Retail Workers	Office Workers	Housing Units	Total Workers	Retail Workers	Office Workers
1138	8%	17	19	0	15	7	8	0	7
1137	47%	103	50	0	41	44	50	0	41
1135	14%	31	0	0	0	13	15	0	12
1139	32%	71	0	0	0	31	35	0	28

Background growth takes into account possible development of underutilized or vacant land located in residential zoning districts in the 2020-2050 forecast years. Parcels that fall into this category are considered "soft sites," since they are built to less than 50 percent of their maximum allowable floor area (among other criteria outlined below) and can be further developed with housing units as-of-right, requiring only DOB approval. Background growth should not be seen as a block-by-block analysis, but rather a way of estimating zoned capacity in gross terms by TAZ in areas where policy changes to spur growth are not currently anticipated.

Tax lots were analyzed in MapPLUTO, a georeferenced database produced by DCP containing property, zoning and building information. The following types of properties were excluded from the background growth analysis:

- Tax lots less than 2,500 square feet in area
- Publicly owned land, parkland and cemeteries
- Lots with rent-stabilized buildings
- Landmark buildings and buildings in historic districts
- One and two family homes in Brooklyn and Queens. (Many one and two family homes are owner-occupied and located in low-density areas – it is unlikely that these homes will be redeveloped into larger buildings with more units)

Additionally, parcels that intersect any of the other data inputs (Adopted rezonings, pipeline projects, areas of opportunity, DOB data) were excluded from the background growth analysis, since possible development on these properties was already included under a different heading.

The background growth analysis determined the amount of developable residential floor area that could be built as-of-right on underutilized lots, given existing zoning regulations. Total developable floor area was summed to the TAZ level, resulting in a borough-specific proportion for the area that was projected for development by 2050. The amount of background growth assumed to be completed by borough was a function of how many housing units were projected in the Borough Planner database for each borough. If the number of housing units projected from rezonings adopted since 2000 and areas of opportunity were sufficient to meet the 2050 county control for population in a given borough, background growth by TAZ was assumed to be minimal. The specific steps performed in each borough are as follows:

- **Bronx**- Background growth analysis was performed on all parcels in the Bronx that were unaffected by recent rezonings and developments and not included in the DOB dataset. Sixty percent of developable floor area in these areas was assumed to be built by 2050.
- **Brooklyn**- Background growth analysis was performed on all parcels in Brooklyn that were unaffected by recent rezonings and developments and not included in the DOB dataset. Fifty percent of developable floor area in these areas was assumed to be built by 2050.
- **Queens**- Background growth analysis was performed on parcels in Queens that were unaffected by recent rezonings and developments, not included in the DOB dataset, and located in neighborhoods with recent growth (Astoria, Steinway, Elmhurst, North Corona). Twenty-five percent of developable floor area in these areas was assumed to be built by 2050.
- **Manhattan**- Background growth analysis was performed on parcels in Manhattan that were unaffected by recent rezonings and developments, not included in the DOB dataset, and located in neighborhoods with recent residential growth (Midtown, Upper West Side, Harlem). Nine percent of developable floor area in these areas was assumed to be built by 2050.
- **Staten Island**- No background growth was projected to occur by 2050.

Developable floor area for all TAZs was converted to housing units by assuming an equivalency of 1,000 square feet per housing unit.

2.2 TAZ Allocation of Housing and Population Variables

2.2.1 NYC Department of Buildings Data

Three types of data were compiled from the NYC Department of Buildings (DOB): certificates of occupancy, new building permits, and demolition permits. These datasets were geocoded to tax blocks and used to determine change in housing units by TAZ for three forecast intervals, 2010 to 2012, 2012 to 2015, and 2015 to 2020.

1. **Certificates of occupancy** (CofOs) are issued by the DOB when a new building is constructed, or a change in use or egress is made to an existing structure. For this project, only CofOs issued for new residential buildings and selected residential conversions were used to calculate an increase of housing units over time.
2. **Demolition permits** are issued by the DOB to allow the full demolition of any vacant or occupied building. For this project, only demolition permits issued to a building containing residential units were included in the analysis.
3. **New building permits** issued by the DOB before the construction of any new building usually begin with approved plans submitted by the developer. Only **pending** permits for buildings containing residential units were used in this analysis, because permits resulting in a completed building would have a CofO that was already captured in the CofO dataset.

The net increases in housing units between 2010, 2012, and 2015 were calculated at the TAZ-level by summing the residential units in the CofO dataset and subtracting the sum of demolished residential units. Since the 2010 decennial census enumeration was conducted as of April 1, the 2010 to 2012 increment was the net result of CofOs and demolition permits issued between April 1, 2010 and March 31, 2012. Similarly, the 2012 to 2015 increment was the net result of CofOs and demolition permits issued between April 1, 2012 and March 31, 2015.

One component of the 2015 to 2020 housing unit increment was estimated at the TAZ-level by summing the new building permits issued between April 1, 2010 and March 31, 2015, as seen in Figure 2-2. In all NYC boroughs except Staten Island, it was assumed that 80 percent of permitted units would be completed by 2020, which reflected the average completion rate for buildings over the previous seven years. In Staten Island, 100 percent of new building permits were projected to be completed by 2020. This higher rate was adopted in order to ensure that housing levels were consistent with the county population projection for 2020.

2.2.2 TAZ Allocation of Housing Units

The figure below (Figure 2-2) shows the role of the data inputs described earlier in the allocation of housing units to TAZs. And, the allocation of housing is integral to the determination of population for each TAZ. For the 2010 count of housing units by TAZ, the 2010 census count of total housing units was summed from blocks to TAZs. (For portions of Brooklyn and Queens where the Department of City Planning adjusted the housing unit counts to compensate for the Census Bureau's undercount, the adjusted values were assigned to the affected TAZs.²)

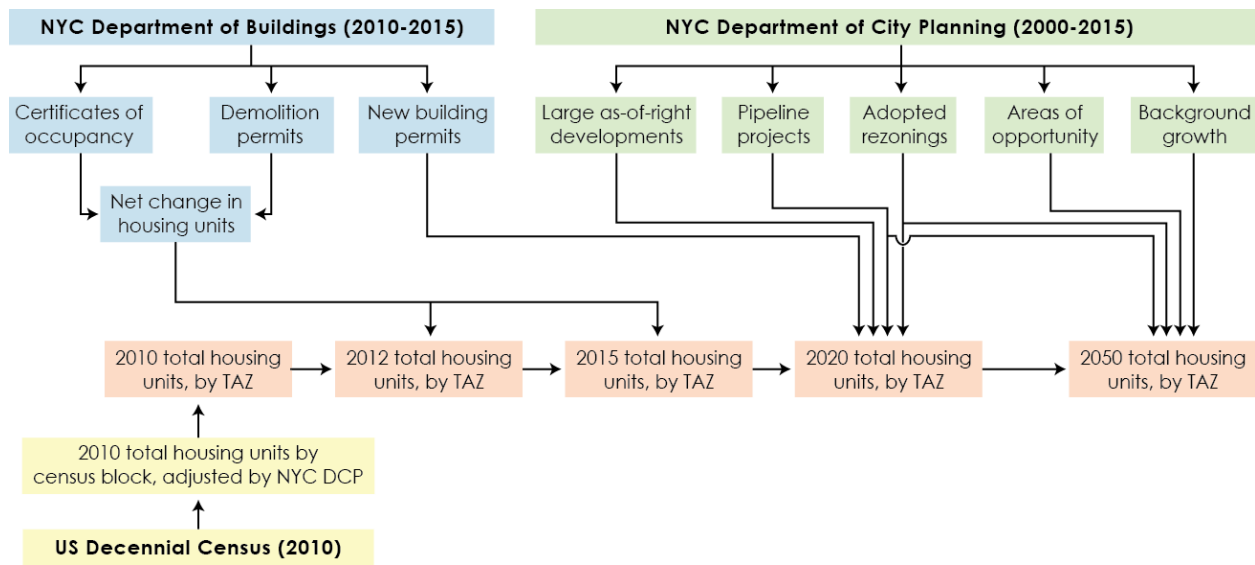
The 2012 and 2015 housing unit estimate was created by adding the housing unit increment from the DOB data to the 2010 housing unit count, as described above. The 2020 estimate of housing units was derived from two different sources, DOB new building permits and the Borough Planner database. The borough-specific portion of new building permits assumed to be completed by 2020 were summed to each TAZ and added to the anticipated number of new housing units generated by large as-of-right developments, pipeline projects and adopted rezonings by 2020.

The 2050 estimate of housing units was derived entirely from data generated by DCP and the project team. The projected increment of housing units added to each TAZ between 2020 and 2050 was summed from pipeline projects, adopted rezonings and areas of opportunity. The borough-specific proportion of housing units arising from background growth, described above, was added to each TAZ as well. This combination of data inputs provided a picture of TAZ-level increases in housing units that was sensitive to growth induced by policy as well as ordinary growth that would occur based solely on the availability of land.

The 2025 to 2045 estimates of housing units by TAZ were interpolated from the 2050 TAZ estimates. The borough-wide population growth rate for each interval year between 2020 and 2050 was applied to the 2020 to 2050 increase in housing units by borough. This resulted in housing unit estimates for 2025 to 2045. The interpolation method assumed that the distribution of growth between all TAZs in a borough was held constant from 2020 to 2050.

² For more information, see: http://www.nyc.gov/html/dcp/html/census/census_challenge_2010.shtml

FIGURE 2-2. TAZ ALLOCATION OF HOUSING UNITS OVERVIEW



2.2.3 Allocation of Housing Units: 2010-2020

Thus, to obtain TAZ-level data for most of the population variables, the project team first had to project the total number of housing units by TAZ. The 2012 and 2015 housing unit estimates were created by adding the housing unit increment from the DOB data, discussed earlier, to the 2010 housing unit count. For units from 2015 to 2020, the project team first estimated the number at the Public Use Microdata Area (PUMA) level (a subcounty geography) by averaging methods 1 and 2 below.

Method 1

When the initial projections were done at the county level as part of Tasks 3 and 4 of the 2050SED Forecast, the DOB data, which were a key element of the short-term projections, were available through 2012. Given that two years of additional data for 2013 and 2014 were available when work on the TAZ allocations began, the project team used these additional data to once again project county-level housing units so as to better adjust PUMA- and TAZ-level data. The project team began with data for building permits issued each year, from 2000 to 2014. Using a demolitions file for the same years, the demolitions were subtracted from the number of building permits issued to derive the net number of permits issued each year. Many of these demolitions were of small structures which will be replaced by larger structures. Unique identifiers in the building permits and in the CofOs, make it possible to track the time elapsed between the issuing of a building permit for a particular project and occupancy of the new units. On average, it takes about six years from the time a permit is issued, to the point where the building is issued a CofO and can be legally occupied. Each building permit was linked to its corresponding CofO over this six year trajectory, in order to derive the percent of building permits that had a CofO issued, on average, in one year, in two years, all the way to six years. Figure 2-3 has some of the data used to calculate the completion rates. Of the 4,636 net building permits issued in the Bronx in 2005, 344 permits had CofOs issued in 2005, and 2,586 CofOs were issued in 2006; in the last year (2010) of the six year trajectory being examined, another 279 CofOs were issued. For the period 2000-2014, for each borough, the number of CofOs for each sequential year (years 1-6) was summed and divided by the net permits issued throughout the period to obtain an average CofO “completion rate” for year one through year six.

To estimate the number of building permits for each year for the 2015-2020 period, building permits for a more recent period, 2007 to 2014, were averaged and the completion rates were applied to this average to derive the estimate of completed units. These estimates are shown in the color red on the Y-axis in the chart below. The X-axis shows how many of these units were completed in one year, in two years, all the way up to six years. When actual data were available, they are highlighted in the color green. For the years 2015 to 2020, the historic completion rates calculated above were applied to the estimated net permits issued to derive the estimated number of completions, which are shown in the color red.

FIGURE 2-3. COMPLETION RATE CALCULATION

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
1	Year	Permits Issued:	Demos	NET Permits	C of O Completion Rates																
2	2000	1,482	46	1,436	1 year	2 year	3 year	4 year	5 year	6 + years	Total										
3	2001	2,318	87	2,231	0.120783	0.624831	0.035088	0.106613	0.072874	0.01552	0.975709										
4	2002	2,636	80	2,556																	
5	2003	3,043	148	2,895																	
6	2004	5,075	177	4,898																	
7	2005	4,849	213	4,636																	
8	2006	4,493	200	4,293																	
9	2007	3,479	194	3,285																	
10	2008	4,761	129	4,632																	
11	2009	2,663	152	2,511																	
12	2010	1,543	103	1,440																	
13	2011	861	78	783																	
14	2012	1,860	96	1,764																	
15	2013	2,461	77	2,384																	
16	2014	1,876	86	1,790																	
17																					
18																					
19					2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
20	2005	4,636			344	2,586	956	392	50	279											
21	2006	4,293				342	2,039	1,142	301	56	200										
22	2007	3,285					244	1,377	1,040	288	153	148									
23	2008	4,632						79	1,110	1,927	904	29	19								
24	2009	2,511							51	910	1,347	167	21	-							
25	2010	1,440								70	341	989	25	-	22						
26	2011	783									64	473	219	-	57	12					
27	2012	1,764										62	523	305	188	129	27				
28	2013	2,384											54	111	84	254	174	37			
29	2014	1,790												-	1,118	63	191	130	28		
30	2015	2,324													281	1,452	82	248	169	36	
31	2016	2,324														281	1,452	82	248	169	
32	2017	2,324															281	1,452	82	248	
33	2018	2,324																281	1,452	82	
34	2019	2,324																	281	1,452	
35	2020	2,324																		281	
36					344	2,928	3,239	2,990	2,552	3,530	3,009	1,868	861	416	1,750	2,190	2,206	2,229	2,259	2,267	
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Once the chart is filled out completely, with net permits along the X-axis, and CofOs issued for these permits in the succeeding six years along the Y-axis, we were able to sum the CofOs on the Y-axis starting in 2010, and for each year out to 2020. This gives us a projection of the number of housing units that will be created within the next ten years. Below, Table 2-1 shows the permit year, the corresponding CofO years that are summarized for the permits issued, and whether actual or estimated data were used.

The number highlighted in blue at the bottom of the worksheet represents the CofOs, with estimates/real data summed to 6+ years from when the building permit was issued to when it was completed and occupied.

TABLE 2-1. CoFO COMPLETIONS

Year Permit Issued	CoFO completion years	Data used: Actual/Estimate
2010	2005-2010	Actual
2011	2006-2011	Actual
2012	2007-2012	Actual
2013	2008-2013	Actual
2014	2009-2014	Actual
2015	2010-2015	Combination
2016	2011-2016	Combination
2017	2012-2017	Combination
2018	2013-2018	Combination
2019	2014-2019	Projection

The project team wanted to complement the borough Cofo estimates with estimates at the PUMA level. Since building permit and demolition data were available at the tax lot level, PUMA geography was geocoded to each individual record and these records were aggregated to the PUMA geography. There are 55 PUMAs in NYC and the borough analysis was replicated for each PUMA.

FIGURE 2-4. COMPLETION RATE CALCULATION WITH PUMA ESTIMATES

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	
1	Year	Permits Issued:	Demos	NET Permits	C of O Completion Rates																
2	2000	7	1	6	1 year	2 year	3 year	4 year	5 year	6 + years	Total										
3	2001	34	3	31	0.022017	0.238095	0.10087	0.108039	0.034306	0.134665	0.637993										
4	2002	65	2	63																	
5	2003	216	7	209																	
6	2004	396	28	368																	
7	2005	130	17	113																	
8	2006	344	8	336																	
9	2007	105	8	97																	
10	2008	92	13	79																	
11	2009	75	7	68																	
12	2010	94		94																	
13	2011	37		37																	
14	2012	2	7	-5																	
15	2013	118	7	111																	
16	2014	238	6	232																	
17																					
18																					
19						2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
20		2005	113			2	35	6	27	6	42										
21		2006	336				8	185	-	6	8	74									
22		2007	97					6	12	5	14	-	61								
23		2008	79						15	18	-	1	20	-							
24		2009	68							-	6	2	63	-							
25		2010	94										91	-							
26		2011	37											-							
27		2012	-5												-						
28		2013	111													-					
29		2014	232														-				
30		2015	89															-			
31		2016	89																-		
32		2017	89																	-	
33		2018	89																		-
34		2019	89																		
35		2020	89																		
36						2	43	197	54	35	70	77	235	-	-	82	63	60	65	76	57
37																					

The estimates of CofOs for each PUMA were in the same format as the borough worksheets. For each PUMA, housing permits for the period 2000 to 2014 were used to estimate completion rates; for the estimated net number of units for each year from 2015 to 2020, the average for 2007 to 2014 was used. PUMA-level completion rates were applied to PUMA-specific permits out to the projected year. Essentially, the same methods for estimating borough CofOs were used at the PUMA level.

Since CofOs often have missing geographic information, the PUMA totals fall short of the borough numbers estimated earlier. The final step was to control the PUMA estimates to the borough total. This

was done by distributing the borough total of the estimated CofOs to each PUMA using the PUMA distribution of these data. For each borough, this PUMA distribution was further normalized on the number of additional housing units for the 2010-2020 period that was projected for each borough (and submitted earlier).

Method 2

While Method 1 came up with projected housing units by analyzing permits issued, and completion rates, from the recent past, Method 2 complements this analysis by taking a look ahead and incorporating future projects. The project team started out with the net addition of housing units (based on CofOs) by PUMA between April 1, 2010 and March 31, 2015. 80% of outstanding housing permits issued in each PUMA since 2010 were added; for Staten Island PUMAs, all housing permits outstanding since 2010 were added to the CofOs issued between 2010 and 2015. To arrive at the 2020 projected number of units by borough, additional units were allocated to each PUMA in proportion to the number of future units based on pipeline projects, EISs, and likely as of right developments (planner database inputs discussed earlier) in each borough.

Housing Units for 2015 and 2020 by Bronx PUMAs				
PUMA	CofOs from April 1 to March 31, 2015	80% of Outstanding housing permits	Additional Units based on future developments	TOTAL
BX 3701	395	317	415	1,126
BX 3702	1,017	522	191	1,731
BX 3703	338	64	71	473
BX 3704	215	66	274	554
BX 3705	3,379	1,302	3,735	8,417
BX 3706	912	260	279	1,451
BX 3707	795	290	640	1,725
BX 3708	1,069	311	1,046	2,426
BX 3709	641	522	-	1,163
BX 3710	2,543	854	1,128	4,525

Averaging Methods 1 and 2

PUMA numbers derived using methods 1 and 2 detailed above were then averaged to arrive at the projected number of units added by PUMA for the decade 2010-2020. The CofOs from 2010-2015 by PUMA were subtracted from the 2010-2020 PUMA totals to arrive at the initial number of projected housing units for 2015-2020. Housing units in PUMA 3708 (Concourse, Highbridge & Mount Eden) were increased by 450 to take into account current rezoning – other Bronx PUMAs were adjusted downward proportionately. In Manhattan, PUMA 3807 (Chelsea, Clinton & Midtown Business District), was increased by 4,650 units and Brooklyn's PUMA 4001 (Greenpoint and Williamsburg) was increased by 3,800 units.

2.2.4 Allocation of Housing Units: 2020 to 2050

The 2050 estimate of housing units was derived entirely from data generated by DCP and the project team. The projected increment of housing units added to each TAZ between 2020 and 2050 was summed from pipeline projects, adopted rezonings, areas of opportunity, as well as from background growth. This combination of data inputs provided a picture of TAZ-level increases in housing units between 2020 and 2050 that was sensitive to growth induced by policy, as well as ordinary growth that would occur based solely on the availability of land. These additions by TAZ for the 2020-2050 period were then summed to the PUMA level. This PUMA distribution was applied to each borough's projected housing unit increase (submitted earlier) for each 5 year increment in the 2020 to 2050 period to obtain adjusted PUMA projected increases for each time point. (These adjusted PUMA totals were then allocated down to the TAZ level using the distribution of the original 2020-2050 TAZ data.)

2.2.5 TAZ Allocation of Population Variables

Before allocations were done at the TAZ level, projections were prepared for each of the following variables at the PUMA level:

- Occupied housing units
- Total Population
- Population In households
- Population in Group Quarters
- Average Household Size (Occupancy Rates)

Projecting forward, an effort was made to maintain 2010 occupancy rates and average household size. Thus, in general, occupancy rates and household size were minimally adjusted to meet PUMA and borough totals. The group quarters population was kept constant at the 2010 level. (Data for the Bronx and Bronx PUMAs are shown for 2025 in Figure 2-5 below.)

FIGURE 2-5. SAMPLE BRONX PUMA POPULATION DATA

	2025 Projections											
BRONX	14,720	1,485,275	46,710	550,207	0.94	519,631	45		2.77	1,438,565	-1,064	
PUMA	2020-25 Units Added	Total Population	Total GQ	Total housing units	Occupancy Rate	Occupied housing units	ADJUSTED Occupied housing units	ADJUSTED Occupancy Rate	Average household size	Population In households	ADJUSTED Population In households	ADJUSTED Average household size
BX TOTAL	14,720	1,485,275	46,710	550,207	0.00	519,586	519,631	0.94	0.00	1,439,629	1,438,565	2.77
3701	952	112,245	5,356	47,957	0.94	44,941	44,945	0.94	2.38	106,968	106,889	2.38
3702	696	145,212	1,852	55,141	0.94	51,587	51,591	0.94	2.78	143,467	143,360	2.78
3703	173	116,274	3,394	50,855	0.95	48,428	48,432	0.95	2.33	112,964	112,880	2.33
3704	1,546	128,843	4,431	49,766	0.94	46,999	47,003	0.94	2.65	124,504	124,412	2.65
3705	2,668	188,485	6,447	67,277	0.94	63,301	63,306	0.94	2.88	182,173	182,038	2.88
3706	1,033	134,050	2,689	48,197	0.95	45,623	45,627	0.95	2.88	131,458	131,361	2.88
3707	1,925	144,639	3,222	49,413	0.94	46,485	46,489	0.94	3.04	141,522	141,417	3.04
3708	2,331	153,018	2,719	54,182	0.95	51,708	51,713	0.95	2.91	150,411	150,299	2.91
3709	1,307	187,955	1,361	70,755	0.95	67,302	67,307	0.95	2.77	186,732	186,594	2.77
3710	2,089	174,553	15,239	56,664	0.94	53,212	53,217	0.94	3.00	159,432	159,314	2.99

The total number of housing units in 2025 is the sum of housing units in 2020 and the increment between 2020 and 2025 (shown as "total housing units added"). The 2010 occupancy rate is applied to each PUMA to get the number of occupied housing units. These units are then adjusted proportionately ("adjusted occupied housing units"), to fit the total number of occupied units in the borough. The occupancy rate is then re-calculated ("adjusted occupancy rate") to take into account the adjusted number of occupied units. The 2010 average household size is then applied to the adjusted number of occupied units to obtain the population in households. This population is then proportionately adjusted ("adjusted population in households") to fit the household population at the borough level. Household size is then re-calculated ("adjusted average household size") to take into account the adjusted population in households, as well

as the adjusted number of occupied housing units. The total population is the sum of adjusted population in households and the 2010 group quarters population.

2.2.6 Projections at the TAZ Level

To obtain TAZ-level data for most population variables, the project team first projected the total number of housing units by TAZ. The 2010-2012 and 2012-2015 increments in housing unit estimates by TAZ were created from the DOB data, discussed earlier. For the TAZ housing unit increment from 2015 to 2020, 80% of outstanding housing permits issued since 2010 were used; for Staten Island TAZs, all housing permits outstanding since 2010 were included. These units at the TAZ level were then proportionately fitted to the PUMA increments discussed earlier. For TAZ increments between 2020 and 2025, and for every five year interval thereafter to 2050, units were summed from the Planner database of as-of-right projects, units in the pipeline, adopted rezonings, areas of opportunity, as well as from background growth. These TAZ increments in housing units were fitted to the adjusted PUMA totals derived earlier. For Breezy Point in Queens, the occupancy rate was reduced for 2015 (due to the destruction caused by superstorm Sandy and the resulting fire in 2012) and increased to its 2010 level in 2030.³

The process for calculating the TAZ allocation is similar to the calculation at the PUMA level. However, instead of using borough controls to calculate each PUMA within the borough, the new PUMA calculations were used to control for TAZs within a PUMA. (Data for Bronx TAZs within PUMA 3701 are shown for 2025 in Figure 2-6 below.)

The total number of housing units for each TAZ in 2025 is the sum of housing units in 2020 and the increment between 2020 and 2025 (shown as “total housing units added”). The 2010 occupancy rate is applied to each TAZ to get the number of occupied housing units. These units were then adjusted proportionately (“adjusted occupied housing units”), to fit the total number of occupied units in the PUMA. The occupancy rate is then re-calculated (“adjusted occupancy rate”) to take into account the adjusted number of occupied units. The 2010 average household size is then applied to the adjusted number of occupied units to obtain the population in households. This population is then proportionately adjusted (“adjusted population in households”) to fit the household population in the PUMA. Household size is then re-calculated (“adjusted average household size”) to take into account the adjusted population in households, as well as the adjusted number of occupied housing units. The total population for each TAZ is the sum of adjusted population in households and the 2010 GQ population.

³ Breezy Point was the only neighborhood which was affected on such a large scale so as to necessitate a model override of occupancy rates.

FIGURE 2-6. SAMPLE BRONX TAZs POPULATION DATA

		2025 Projections											
PUMA 3701		952	112,245	5,356	47,957	0.94	44,945	-8		2.38	106,889	-128	
TAZ	CT2010 Equiv	Total housing units Added	Total Population	Total GQ	Total housing units	Occupancy Rate	Occupied housing units	ADJUSTED Occupied housing units	ADJUSTED Occupancy Rate	Average household size	Population in households	ADJUSTED Population in households	ADJUSTED Average household size
Total 3701		952	112,245	5,356	47,957	0.00	44,952	44,945	0.94	0.00	107,017	106,889	2.38
1151	2040303	64	4,746	99	1,658	0.96	1,595	1,595	0.96	2.92	4,653	4,647	2.91
1152	2040304	80	4,022	0	1,344	0.96	1,297	1,296	0.96	3.11	4,027	4,022	3.10
1153	2040701	47	3,465	0	1,268	0.96	1,215	1,215	0.96	2.86	3,469	3,465	2.85
1165	2040900	23	3,683	0	1,499	0.97	1,454	1,454	0.97	2.54	3,687	3,683	2.53
1166	2026701	17	4,073	0	1,405	0.96	1,355	1,355	0.96	3.01	4,078	4,073	3.01
1167	2026702	61	7,201	14	2,554	0.97	2,465	2,465	0.96	2.92	7,195	7,187	2.92
1168	2027700	27	5,153	8	1,885	0.96	1,805	1,805	0.96	2.86	5,158	5,151	2.85
1169	2027300	64	8,364	236	2,825	0.96	2,704	2,703	0.96	3.01	8,138	8,128	3.01
1170	2027900	30	7,325	366	3,144	0.95	2,982	2,982	0.95	2.34	6,968	6,959	2.33
1171	2028100	42	3,866	260	1,832	0.98	1,802	1,802	0.98	2.00	3,610	3,606	2.00
1172	2028300	58	3,280	11	1,418	0.96	1,366	1,366	0.96	2.40	3,273	3,269	2.39
1173	2028900	76	5,002	193	2,041	0.95	1,933	1,933	0.95	2.49	4,815	4,809	2.49
1174	2028500	59	3,656	0	1,884	0.93	1,746	1,746	0.93	2.10	3,661	3,656	2.09
1175	2028700	38	3,263	6	1,303	0.94	1,221	1,221	0.94	2.67	3,261	3,257	2.67
1176	2029301	0	1,869	174	994	0.91	905	905	0.91	1.88	1,698	1,695	1.87
1177	2029302	13	5,075	133	2,907	0.91	2,648	2,648	0.91	1.87	4,948	4,942	1.87
1178	2030100	3	1,353	299	657	0.90	591	590	0.90	1.80	1,061	1,060	1.80
1179	2029500	58	4,438	18	2,290	0.92	2,106	2,106	0.92	2.10	4,425	4,420	2.10
1180	2029700	4	3,556	182	1,892	0.88	1,673	1,672	0.88	2.02	3,378	3,374	2.02
1181	2035100	48	3,417	887	1,292	0.93	1,204	1,203	0.93	2.11	2,533	2,530	2.10
1182	2033500	41	2,282	493	863	0.92	798	798	0.92	2.25	1,791	1,789	2.24
1183	2034300	6	1,669	217	653	0.93	605	605	0.93	2.40	1,453	1,452	2.40
1184	2033700	21	2,403	25	1,038	0.90	930	930	0.90	2.56	2,381	2,378	2.56
1185	2034500	8	3,674	85	1,825	0.93	1,695	1,694	0.93	2.12	3,594	3,589	2.12
1186	2032300	46	4,974	40	2,917	0.93	2,724	2,723	0.93	1.81	4,940	4,934	1.81
1187	2031900	0	751	751	0	0.00	0	0	0.00	0.00	0	0	0.00
1188	2030900	7	4,265	859	1,647	0.92	1,523	1,523	0.92	2.24	3,410	3,406	2.24
1189	2030701	10	5,405	0	2,922	0.89	2,612	2,611	0.89	2.07	5,411	5,405	2.07

2.2.7 TAZ Allocation of Group Quarters Population

A group quarters is a place where people live or stay that is normally owned or managed by an entity or organization providing housing and/or services for the residents. People living in group quarters are usually not related to each other. The group quarters population is divided into two major sub-categories: those living in either institutionalized or noninstitutionalized settings. People under formally authorized, supervised care or custody in institutions at the time of enumeration are part of the institutional group quarters population. Institutional Group Quarters includes correctional facilities for adults, juvenile facilities, nursing homes/skilled nursing facilities. Non-institutional group quarters include college residence halls, residential treatment centers, group homes, military barracks, and facilities for people experiencing homelessness. While the census does not provide a count of all homeless persons, an important part of the 2010 Census was a service-based enumeration, which sought to count persons without a usual residence, who used service facilities (emergency or transitional shelters, soup kitchens, and mobile food vans). Detailed group quarters population categories were available by census tract from the 2010 decennial census.⁴

For the TAZ allocation, the group quarters population (185,500 persons) was divided three subgroups:

1. Institutional group quarters population (70,000).

⁴ Census tract data were used except for a few instances where a census tract was split into multiple TAZs. For these few cases, census block data were used. Since the group quarters population living in emergency and transitional shelters for people experiencing homelessness is not provided at the block level, this population was split amongst the census blocks within the census tract that had "other noninstitutional group quarters population."

2. Noninstitutional group quarters population from the service-based enumeration⁵ (29,600).
3. Other noninstitutionalized group quarters population (85,900). This category was derived by removing those enumerated as part of the serviced enumeration from the total noninstitutional group quarters population.

The largest group quarters population was in Manhattan (67,400), where the majority were living in other noninstitutionalized facilities, principally college and university housing, in or adjacent to TAZs with large universities. The largest institutionalized group quarters population (11,000 persons) was located in TAZ 1343 in the Bronx, which is the correctional facility on Rikers Island. The Bronx, Brooklyn and Manhattan each had between 8,000 and 9,000 persons in the service-based group quarters population, followed by Queens (3,400 persons) and Staten Island (300 persons).

TABLE 2-2. GROUP QUARTERS POPULATION

	Total Group Quarters Population	Institutionalized Group Quarters Population	Service-based Group Quarters Population	Other Noninstitutionalized Group Quarters
NYC	185,530	70,041	29,562	85,927
Bronx	46,710	25,437	8,990	12,283
Brooklyn	35,609	13,297	8,409	13,903
Manhattan	67,373	12,081	8,496	46,796
Queens	28,000	15,364	3,408	9,228
Staten Island	7,838	3,862	259	3,717

New York City's group quarters population in each county was held constant at 2010 levels, given the absence of any firm basis for forecasting the location of group quarters facilities. The same approach was implemented at the TAZ level.

2.3 Allocation of K-12 and University Enrollment

2.3.1 K-12 Enrollment

The New York State Education Department (NYSED) releases administrative data for public, charter, and private school enrollment by school location for grades K-12 annually.⁶ The school enrollment projections were done using a bottom-up approach, working from a base of the most recent available data for the 2013-2014 enrollment year. School enrollment by grade and gender from NYSED was linked to five-year age groups, using the following age-grade equivalency:

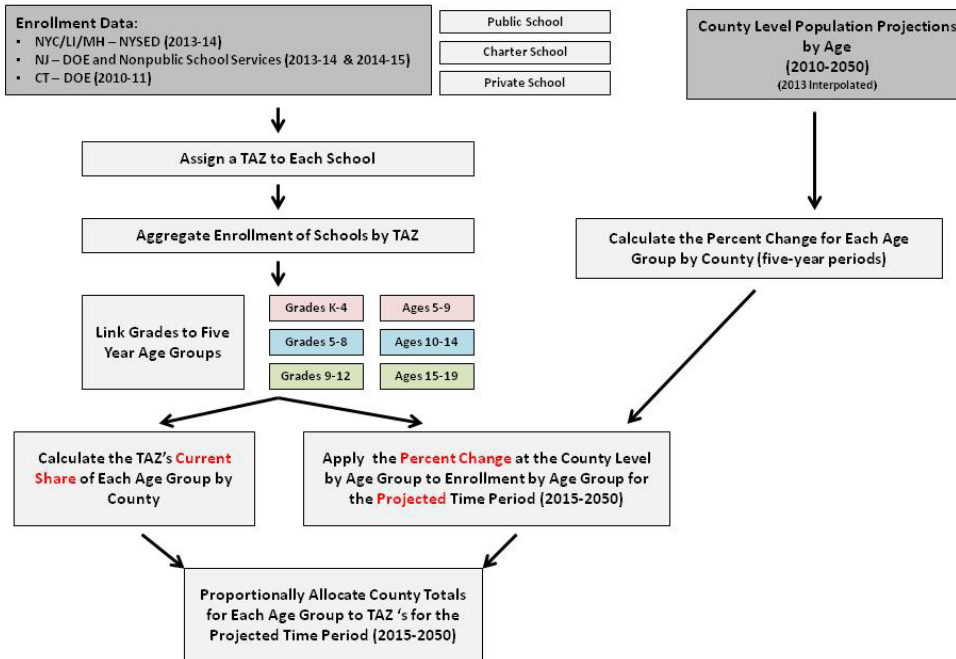
- Grades K-4: Ages 5-9
- Grades 5-8: Ages 10-14
- Grades 9-12: Ages 15-19

⁵ While those enumerated in soup kitchens and mobile food vans were actually part of the service-based enumeration, they could not be separately identified. For tabulation purposes they were included in "other noninstitutionalized group quarters population," along with persons in living quarters for victims of natural disasters and those living in religious group quarters and domestic violence shelters. Therefore, the number of persons included in the service-based enumeration, shown here, consists of those in emergency or transitional shelters.

⁶ See <http://www.p12.nysed.gov/irs/statistics/public/home.html>

Reported enrollments by school were aggregated for each county for the base year⁷ and then projected forward using changes in the population of selected age/sex groups from county population projections.⁸

FIGURE 2-7. K-12 ENROLLMENT BY TAZ



K-12 enrollment in New York City was estimated at 1,276,000 in 2010 and is projected to reach 1,361,000 in 2050, an increase of 84,000 or 6.6 percent. School enrollment is projected to increase modestly (1.2 percent) over the current decade, reaching 1,292,000 in 2020; in the following decade, it is projected to grow 5.3 percent, to 1,360,000 by 2030. Larger cohorts of women born in the late 1980s and early 1990s, along with modest positive net migration in the older school-age population are driving changes in the number of school-age children. Since changes in school-age population by county were applied to the enrollment figures, large projected population increases influence projected enrollment. By 2040, however, the school-age population is projected to dip slightly (down 0.2 percent). School enrollment is projected to slightly increase again in the following decade to 1,361,000 (by 0.3 percent).

By county, Brooklyn is projected to see the largest overall percentage increase in enrollment between 2010 and 2050 (8.7 percent), followed by Queens and the Bronx (8.3 and 7.4 percent, respectively). Manhattan is projected to have a modest increase of 2.5 percent. Staten Island is the only county within New York City where enrollment is projected to decline between 2020 and 2050, from 75,000 to 73,000 (-2.9 percent).

⁷ The 2013 ratio of enrollment to population by age group was applied to the 2010 and 2012 populations to produce county enrollment, since complete enrollment data by school were not available for previous years.

⁸ It is important to note that residence may not be a good indicator of a person's school location, which translates into differences between school enrollment and school-age population for geographic areas.

TABLE 2-3. K-12 ENROLLMENT

	2010	2012	2015	2020	2025	2030	2035	2040	2045	2050
NYC	1,276,431	1,272,074	1,265,538	1,291,697	1,336,863	1,359,833	1,363,372	1,356,461	1,350,044	1,360,547
Bronx	252,704	249,359	244,341	246,293	256,523	263,983	267,396	268,015	267,876	270,929
Brooklyn	415,191	415,680	416,414	429,562	446,104	450,094	446,848	444,183	444,971	451,386
Manhatta	215,099	213,566	211,268	216,710	229,380	236,623	236,718	229,958	222,159	220,401
Queens	318,322	318,990	319,992	326,142	331,963	335,549	338,177	340,214	341,552	344,873
Staten Is.	75,115	74,478	73,523	72,991	72,893	73,584	74,233	74,091	73,485	72,959

For 2013 enrollment, each school was geocoded and assigned a census block and TAZ, and school enrollment was aggregated to the TAZ level. Since this process did not attempt to predict the location of new schools, projected enrollment was only allocated to TAZs in which a school already exists, the current TAZ share of the county was applied to projected county enrollment to derive projected enrollment by TAZ.

2.3.2 University Enrollment

University enrollment by location was available from The New York State Education Department (NYSED).⁹ Enrollment data were reported at a university's main campus location; individual programs and buildings within the university were not separately reported in the NYSED database.¹⁰ Satellite campuses of a university, typically in a different county than the main campus, were included in the database. Data for the New York City counties were also available from the Department of City Planning Facilities Database. Since the population eligible for university enrollment goes well beyond the boundaries of the city, national trends were used to project NYC's university enrollment.

To project university enrollment, we relied on data from the National Center for Education Statistics (NCES), which releases projected national university enrollment to 2021, as well as the U.S. Census Bureau's national projections by age to 2060.¹¹ The share of the national population that is projected to be enrolled at the university level has increased since 2010, but at a slower rate, compared with the prior decade, 2000-2010. To estimate future growth, a quarter of the difference in the shares of the population ages 15+ that were enrolled in 2000 and in 2020 was taken, and added to each decade post-2020 (the 2020 ratio is shown in teal on the right, in Figure 2-9), which was then used to derive the projected national population enrolled in universities.¹² This process did not attempt to include a capacity constraint on the growth of enrollment for each university because there are many factors, including changes in infrastructure, costs, and technological changes, which could impact future enrollment in ways that are impossible to predict. Therefore, the projections are based on current shares of enrollment. For the base year 2013, national university enrollment data were used to establish the ratio of county enrollment relative to that for the nation (shown in purple on the right, in the county enrollment table below). This ratio was then applied to the projected enrollment for the nation to derive enrollment by county at each projected time point.

⁹ See http://eservices.nysed.gov/orisre/r_creditenrollment.jsp

¹⁰ Included in the database are universities and colleges categorized as State University of New York (SUNY), City University of New York (CUNY), independent (private-not-for-profit), and proprietary (private-for-profit).

¹¹ See <http://nces.ed.gov/programs/projections/projections2021/> and <http://www.census.gov/population/projections/data/national/2014/summarytables.html>

¹² Since we assumed that recent increases in enrollment could not be maintained over the projection period, one-quarter of the difference in the nation's share of enrollment for 2000 and 2020 was used to move national enrollment forward.

FIGURE 2-8. UNIVERSITY ENROLLMENT BY TAZ – OVERVIEW

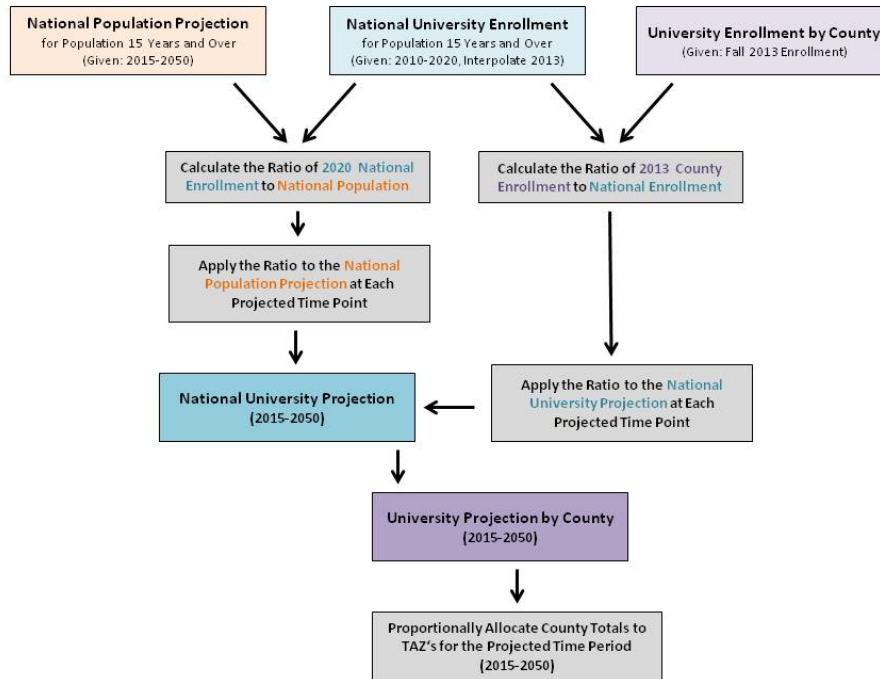


FIGURE 2-9. UNIVERSITY ENROLLMENT BY TAZ – CALCULATIONS

NATIONAL CENSUS PROJECTION BY AGE											
	2000	2010	Census Population Projection								
Total Population	281,421,906	308,745,538	2015	2020	2025	2030	2035	2040	2045	2050	
Population 15 and Over	221,168,531	247,518,325	321,369,000	334,503,000	347,335,000	359,402,000	370,338,000	380,219,000	389,394,000	398,328,000	
			260,351,000	272,928,000	284,881,000	295,695,000	305,889,000	315,276,000	323,824,000	331,853,000	
NATIONAL UNIVERSITY ENROLLMENT											
	NCES	NCES	INTERPOLATED	NCES PROJECTED		National University Enrollment Projection as a Percentage of National Population Projection					
	2000	2010	2013	2015	2020	2025	2030	2035	2040	2045	2050
Population 15 and Over	15,312,289	21,016,123	21,757,844	22,252,324	23,866,783	25,560,628	27,204,110	28,838,382	30,441,151	32,003,744	33,552,786
Ratio National Enrollment to Population 15 and Over	0.0692	0.0849		0.0855	0.0874	0.0897	0.0920	0.0943	0.0966	0.0988	0.1011
COUNTY UNIVERSITY ENROLLMENT											
			NYSED	NYC University Enrollment Projection as a Percentage of National University Enrollment Projection							
			Fall 2013 Enrollment	2015	2020	2025	2030	2035	2040	2045	2050
NYC			534,113	546,252	585,883	627,464	667,808	707,927	747,271	785,630	823,656
Bronx			59,455	60,806	65,218	69,846	74,337	78,803	83,183	87,453	91,686
Brooklyn			93,714	95,844	102,797	110,093	117,172	124,211	131,114	137,844	144,516
Manhattan			275,526	281,788	302,232	323,682	344,494	365,189	385,485	405,273	424,889
Queens			88,003	90,003	96,533	103,384	110,031	116,641	123,124	129,444	135,709
Staten Island			17,415	17,811	19,103	20,459	21,774	23,082	24,365	25,616	26,856
National Population Projections National University Projections NYC 2013-2014 University Enrollment											
			http://www.census.gov/population/projections/data/national/2014/summarytables.html http://nces.ed.gov/ipeds/data/ipedsreports/2014/index.asp http://eservices.nySED.gov/irs/ir_credits/enrollment.jsp								

2020 National Enrollment to National
0.087

Ratio of 2013 County Enrollment to National
0.003
0.004
0.013
0.004
0.001

Manhattan's enrollment accounts for over one-half of New York City's university enrollment due to several large universities.

From 2010 to 2050, Manhattan is projected to see an increase of 232,000 enrolled university students. Enrollment in universities is projected to increase by 58,000 in Brooklyn and 49,000 in Queens. Universities in the Bronx are projected to increase enrollment by 34,000 persons. Staten Island, the county in New York City with the fewest universities, is projected to increase by more than 10,000 students.

TABLE 2-4. UNIVERSITY ENROLLMENT

	2010	2012	2015	2020	2025	2030	2035	2040	2045	2050
NYC	530,186	535,919	546,252	585,883	627,464	667,808	707,927	747,271	785,630	823,656
Bronx	57,899	59,065	60,806	65,218	69,846	74,337	78,803	83,183	87,453	91,686
Brooklyn	93,371	92,375	95,844	102,797	110,093	117,172	124,211	131,114	137,844	144,516
Manhattan	275,659	279,105	281,788	302,232	323,682	344,494	365,189	385,485	405,273	424,889
Queens	86,797	88,114	90,003	96,533	103,384	110,031	116,641	123,124	129,444	135,709
Staten Is.	16,460	17,260	17,811	19,103	20,459	21,774	23,082	24,365	25,616	26,856

Each university was geocoded to a census block and assigned a TAZ. The 2013 enrollment was then aggregated to the TAZ level. The 2013 TAZ share of each county was applied to projected county enrollment to derive TAZ level enrollment. Enrollment at Cornell Tech's upcoming campus, which will be located on Roosevelt Island, was included at two time points: The campus is projected to be partially built by 2020 and expected to be completed for full enrollment by 2040. While Cornell Tech's growth was included at the TAZ level, other TAZs were proportionately reduced, leaving overall projected growth in Manhattan unchanged.

2.4 Employed Civilian Labor Force

The employed civilian labor force (ECLF) variable is residence based, and measures how many people who live in a TAZ hold jobs outside of the armed forces. The most recent ECLF data are from the 2008-2012 five-year ACS estimates at the census tract level. These estimates provide an average number of employed civilians over the five-year period, and were used to calculate a ratio of employed persons to the total population in each tract, which was then converted to TAZ. This ratio of employed civilians to the total population was held constant for all TAZs in the city since it was considered unrealistic to project changes at such small geographies. These ratios were then applied to the projected TAZ population at each five-year time point to produce projections of the employed civilian labor force.

Finally, TAZ estimates of ECLF were normalized to the borough control total, so that the sum of each TAZ in a borough matches exactly the PFAC-adopted total ECLF.

2.5 Allocation of Average Household Income

The data source for household income was the 2008-2012 American Community Survey 5-Year Estimates. Average household income was calculated by dividing the aggregate household income by the total number of households in each TAZ.¹³ Since the data were calculated in 2012 dollars, an inflation adjustment factor was applied to the results, to produce average household income in 2010 dollars by TAZ. Average household income was held constant for the entire forecast period (2010-2050) since it was considered unrealistic to project changes at such small geographies.

2.6 Allocation of Employment

2.6.1 2010 Allocation of Total, Office and Retail Employment

Overview

The Best Practices Model (BPM) requires data inputs computed for each TAZ in the 28-county region.¹⁴ However, census tracts are the smallest common geography at which the majority of historic socioeconomic data, including employment data, are available. For this reason, the bulk of the analysis is conducted using census tracts, which are subsequently converted to TAZs. TAZs are typically coterminous with census tracts, but may split tracts, or be composed of multiple tracts. (The method for converting tracts to TAZs will be discussed further into the document.)

Since the specification of employed persons can vary, it is important to have a clear understanding of how employment is defined as a BPM input. For NYMTC's model, the definition of employment at the TAZ level is adopted from the Census Transportation Planning Package (CTPP), a special tabulation of the ACS that provides employment data for census tracts using multi-year estimates. For this survey, employment in a given location is defined as the number of workers, aged 16 years and over, who worked during the survey reference week. This includes people who worked from home, but excludes people who were on leave from work (e.g. sickness, vacation) during the ACS survey reference week. Further, this measure excludes additional trips generated by people who hold multiple jobs.

¹³ For instances where census tracts were split among multiple TAZs, census block household data were used to determine which TAZ should be assigned the average household income. For instances where households are assigned to a TAZ, but no aggregate household income was available, the TAZ was assigned the average household income from an adjacent TAZ.

¹⁴ Three counties are not disaggregated to the TAZ in the Best Practices Model (BPM); these counties are Ulster and Sullivan in New York State and Litchfield in Connecticut.

This methodology employs a standard proportional allocation approach. 2010 employment estimates for each census tract are computed from two different sources and then normalized to 2010 employment in the county where they lie. County-level employment is available from the 2010 American Community Survey (ACS) as a single-year estimate, which uses the same definition of employment as the CTPP. The proportional allocation ensures that the sum of employment for TAZs in a county is equal to the county employment value from the ACS.

2.6.1.1 Data Sources for 2010 Employment Allocation

The employment variable is measured at the workplace, and should not be confused with data relating to the employment status of people by where they live. All data in section 2.6 is tabulated at the workplace. Two sources of employment data are available at the subcounty level to create TAZ employment estimates: the ACS-based CTPP (Part 2: Tabulations for workplace geography), and the Longitudinal Employer-Household Dynamics (LEHD-LODES) dataset. Each of these sources has its own advantages and limitations. In order to generate a more accurate subcounty employment estimate and take advantage of the strengths of each dataset, the project team combined the two sources to generate a unified total employment estimate by census tract. This method creates a more robust estimate, better than each dataset taken individually. The key differences between the datasets are described in Table 2-5.

TABLE 2-5. DIFFERENCES BETWEEN CTPP AND LEHD DATA

	Census Transportation Planning Package (CTPP Part 2: Workplace, Table A202104)	Longitudinal Employer-Household Dynamics (LEHD-LODES)
Principal data source	American Community Survey (ACS)	Quarterly Census of Employment and Wages
Smallest geographic area	Census tracts	Census blocks
Years available	One multi-year average from 2006-2010 survey responses	Individual years, from 2002-2011 ¹⁵
Coverage/sampling error	Sizeable error in areas with poor survey coverage	Full/None
Headquartering bias error	None	Sizeable in certain locations
Universe of workers captured	All workers, including those not in the State Unemployment Insurance system ¹⁶ and sole-proprietors	Payroll workers only (employees eligible for unemployment insurance)
Public employee subset	Available	Available for 2010 and 2011 but unreliable ¹⁷

The most significant strength of the CTPP dataset is its representation of the entire universe of workers in a given location. This is especially important when estimating employment in tracts where government employees, sole-proprietors, and people working “off the books” are prevalent. These segments of the workforce are either excluded entirely from or counted inconsistently in the Quarterly Census of Employment and Wages (QCEW), which is used as the primary input to the LEHD datasets. The CTPP, however, is subject to substantial sampling error at the census tract level. By contrast, the key strengths of the LEHD datasets are their temporal precision, ability to reveal documented changes in insured employment over time, and the absence of sampling error in the estimates. Based on analysis conducted by the project team, the LEHD and CTPP data can be unified into a single dataset that

¹⁵ The LEHD-LODES data only includes workers who were employed at a firm in both the 1st and 2nd quarters of the reference year.

¹⁶ Workers excluded from the State Unemployment Insurance system include sole-employed individuals, workers compensated with only cash, family employees, uniformed military, and other small groups. Government employees are covered by UI systems, but are not allocated reliably to small area geographies in the QCEW and LEHD databases.

¹⁷ For more information about reliability of the LEHD data, see *NCHRP o8-36, Task o98 Improving Employment Data for Transportation Planning* (<http://www.camsys.com/pubs/NCHRPo8-36-98.pdf>).

provides a comprehensive estimate of workers at private firms at the census tract level. Therefore, this methodology leverages the strengths of both data sources to estimate total employment in 2010 at the tract-level, and ultimately the TAZ-level, as required by the BPM.

In order to make comparisons between the CTPP and LEHD datasets, it is essential that both measure employment consistently. The CTPP dataset provides an estimate of workers based on survey responses, whereas QCEW collects unemployment insurance data from administrative records maintained by state Departments of Labor. The QCEW generally provides information for all payroll jobs, including those held by multiple job-holders. This analysis, however, uses an LEHD dataset that is restricted to primary jobs (henceforth referred to as workers), enabling more valid comparisons with CTPP estimates of workers.

The CTPP is the only reliable source for small-area estimates of two significant portions of the workforce, government workers and sole-proprietors. Estimates for those groups are taken directly from the CTPP and are kept unchanged in our analysis. The remaining and largest segment of the workforce -- employees at private firms -- is represented in both the CTPP and LEHD datasets. A combination of both datasets is therefore used to generate the most reasonable estimate of workers at private firms. To do this, the project team compared LEHD and CTPP estimates of workers at private firms by tract and classified all tracts into two groups referred to here as Type 1 and Type 2 tracts:

Private Workers in Type 1 Tracts

For most census tracts within the 28-county NYMTC BPM region, the CTPP estimate of private workers between 2006 and 2010 is greater than the LEHD count of private payroll workers in 2010. These are referred to as Type 1 tracts in this document. In Type 1 tracts, it is assumed that the higher CTPP estimate results from the presence of non-payroll workers, who are not included in the LEHD dataset. However, because the CTPP estimate is produced from sample data collected for the 2006-2010 period, it is not necessarily a good indicator of actual employment in the 2010 baseline year, especially in areas where significant job gains or losses occurred during that period.

The LEHD data is of greatest value in this analysis when used to determine documented changes in payroll workers at private firms between 2006 and 2010 from administrative data. Therefore the CTPP estimate of workers at private firms is "brought up to 2010" by adding to it the 2006 to 2010 change in payroll workers at private firms derived from LEHD. The result provides an estimate of workers at private firms that work both on and off the books *and* is sensitive to known incremental changes in payroll employment during the sample years.

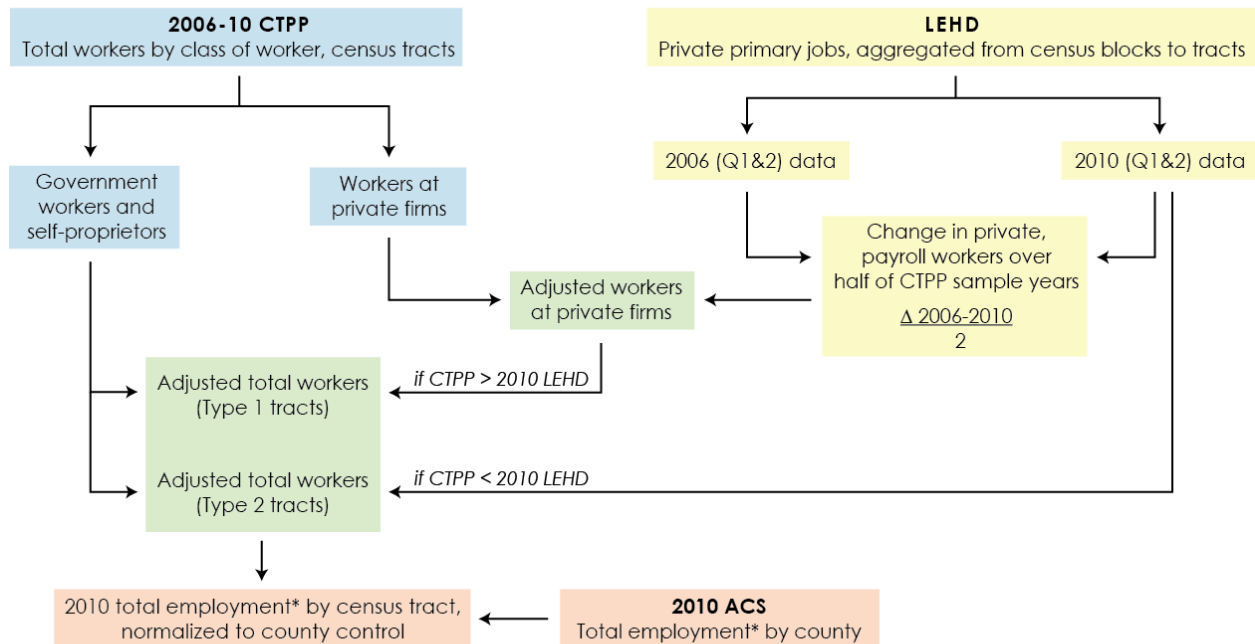
Private Workers in Type 2 Tracts

In Type 2 census tracts the LEHD count of private payroll workers in 2010 is greater than the CTPP estimate of all private workers averaged for the 2006-2010 period. Three possibilities exist as to what conditions would lead to this outcome:

1. There was an ACS undercount of workers in the census tract.
2. There was a very sizeable gain in employment in the tract between 2006 and 2010.
3. A corporate headquarters opened in the tract sometime between 2006 and 2010, and failed to submit the necessary documentation to the state that would have enabled LEHD to geocode workers to their actual job site. This is referred to as headquartering bias.

In these cases, it is assumed that the first two cases are the most likely and therefore the 2010 LEHD count of private payroll workers is applied to the tract, without adjustments. Overall, there were far fewer Type 2 census tracts, compared to the number classified as Type 1.

FIGURE 2-10. ALLOCATION OF TOTAL EMPLOYMENT TO CENSUS TRACTS



* Employment refers to the ACS definition, as workers 16+ who worked during the survey reference week.

2.6.1.2 Application of 2010 Allocation Method

Once an adjusted estimate of workers at private firms is calculated for Type 1 and 2 tracts, government workers and sole-proprietors are added in from the CTPP data, creating an adjusted estimate of total employment in each census tract. This adjusted estimate is used as a relative measure of each tract's **share** of total county employment. To create a final, allocated value of employment, and to ensure that tract estimates add up to the established county-level estimate, each tract's adjusted estimate is normalized to the 2010 county employment total from ACS.

With total employment by census tract determined, the final step is to convert census tracts into TAZ level geography. For TAZs that are aggregates of two or more tracts, the employment in those tracts is simply added together. For TAZs that share a tract with one or more other TAZs, the tract level employment value is split. This is accomplished by using the 2010 LEHD file, which provides total payroll job counts by census block. Though this file is subject to the limitations described above, the availability of block-specific information is a major benefit for dividing the tract data by TAZ, and provides the only available picture of employment at the sub-tract level. Therefore, census block level LEHD employment for 2010 is summed for the TAZs that must be split, and the derived tract employment is proportionally allocated to those TAZs based on their relative share of LEHD employment.

The result of these processes is the generation of a shapefile and table that contain total employment in each TAZ in 2010. Allocations of employment projections for future years will build off this baseline.

2.6.1.3 Determining 2010 Office and Retail Employment

The BPM requires inputs not only of total workers with trips employed within each TAZ but also the number of those workers employed in office and retail jobs. For the purposes of this analysis and the BPM specifications, office workers are defined as those employed in industries with NAICS codes 51 through 56, and retail workers with NAICS codes 44 and 45, as shown in Table 2-6.

TABLE 2-6. NAICS CODES

TAZ Input	NAICS	Industry Description
Office	51	Information
	52	Finance & Insurance
	53	Real Estate, Rental & Leasing
	54	Professional, Scientific & Technical
	55	Mgmt. of Companies & Enterprises
	56	Admin., Support, Waste Mgmt.
Retail	44-45	Retail Trade
Not Specified	11	Agriculture, Forestry, & Fishing
	21	Mining
	22	Utilities
	23	Construction
	31-33	Manufacturing
	42	Wholesale Trade
	48-49	Transportation & Warehousing
	61	Educational Services
	62	Health Care & Social Assistance
	71	Arts, Entertainment & Recreation
	72	Accommodation & Food Services
	81	Other Services
	92	Government

Allocation of office and retail employment follows a similar process as the allocation of total employment described previously. County-level values of office and retail workers are taken from the 2010 ACS, and are distributed to TAZs based on each TAZ's share of the county total.

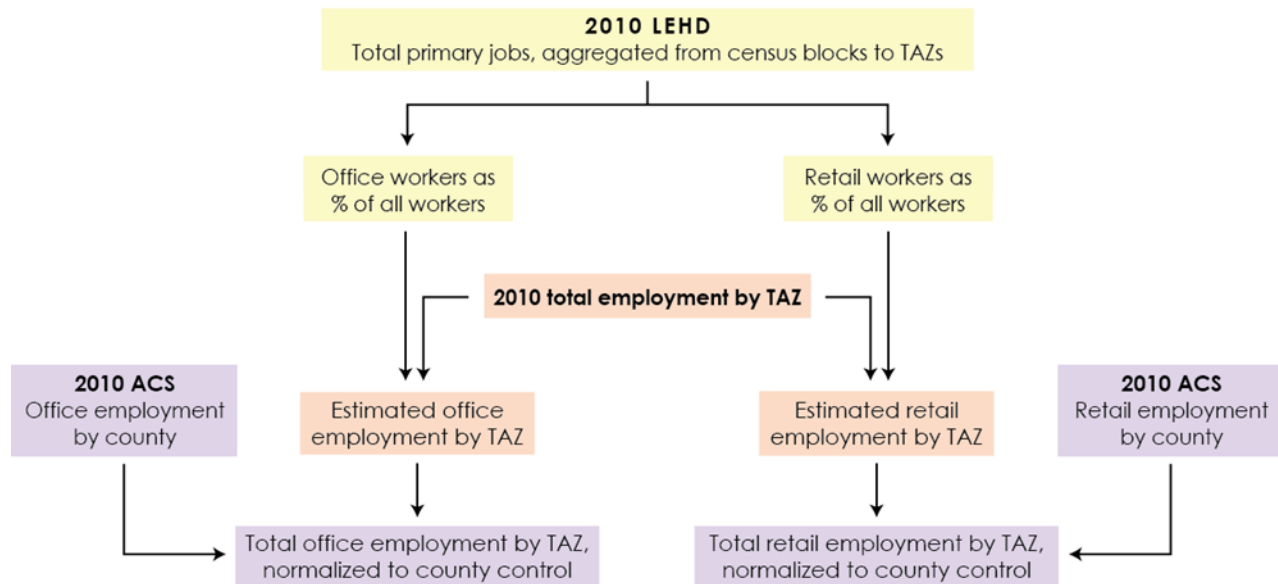
Both the CTPP and LEHD datasets provide industry detail for small area geographies (census tracts and census blocks, respectively). A comparative analysis was conducted by the project team to determine if office and retail employment as a share of each census tract's total employment was similar across the 2006-10 CTPP and 2010 LEHD datasets. It was found that the LEHD data for all primary jobs tends to show higher shares of office and retail employment relative to total employment within a tract. There are two possible reasons for this difference:

1. LEHD is not capturing "off the books" workers and sole-proprietors, who may be disproportionately employed in non-retail or non-office industries.
2. A trend occurred between 2006 and 2010 towards increased rates of office and retail employment.

Regardless, the difference between the two datasets in retail and office shares at the tract level is relatively small. For this reason, combined with the advantage of smaller geography and precise 2010 vintage, the LEHD dataset for all primary jobs is used to determine each TAZ's share of office and retail employment. This share is applied to the total employment within each TAZ (computed in the first part of this methodology) to produce an estimate of office and retail employment by TAZ in 2010.

Finally, the TAZ estimates of office and retail employment are normalized to their respective 2010 county values, taken from ACS Table B08526, which provides an estimate of workers by industry. This normalization ensures that office and retail employment are proportionally allocated to TAZs based on real industry data available in the LEHD datasets while controlling to the ACS county-level estimates.

FIGURE 2-11. ALLOCATION OF OFFICE AND RETAIL EMPLOYMENT TO TAZs



2.6.1.4 Adjustments to County- Level Employment Variables

The NYMTC county-level projections for total, retail, and office employment were reported as the number of jobs located in each county. However, the BPM model inputs require that the TAZ-level employment variables be measured in workers who reported to work during the ACS reference week, not jobs. This difference in definition required a conversion of all county-level employment variables from jobs to workers by the ACS definition. To do this, jobs were divided by the NYMTC region average multiple job holding ratio and by the NYC average ratio of workers on-leave for 2012.¹⁸ This resulted in an adjusted county control value of total workers that was then used to allocate workers to TAZs.

To convert retail and office jobs to workers at the county-level, the percentage of each as a share of total jobs was calculated for each county and time period from detailed industry tables provided by LBG's econometric consultant. This percentage was then applied to the county control value of total workers determined above to produce tables of retail and office workers that were used for the TAZ allocation. A comparison of jobs to workers in the ACS definition is shown in Table 2-7.

¹⁸ The region and NYC averages were used because residence and workplace locations often span county boundaries, thus making county-level averages problematic.

TABLE 2-7. JOBS TO WORKERS COMPARISON

		2010	2012	2015	2020	2025	2030	2035	2040	2045	2050
Total Jobs	Manhattan	2,489,495	2,527,496	2,646,563	2,711,763	2,742,447	2,770,045	2,801,644	2,833,150	2,866,594	2,900,950
	Bronx	380,917	396,442	414,653	425,439	432,437	438,554	444,803	452,145	458,582	465,591
	Brooklyn	823,738	879,865	924,613	945,808	959,058	969,844	983,634	998,422	1,012,438	1,027,032
	Queens	709,096	740,466	771,877	784,688	788,816	792,521	797,664	804,849	807,736	811,754
	Staten Is.	126,397	140,164	147,064	149,309	151,740	153,264	154,778	156,416	157,888	159,430
	NYC	4,529,643	4,684,432	4,904,770	5,017,008	5,074,498	5,124,229	5,182,523	5,244,981	5,303,237	5,364,758

		2010	2012	2015	2020	2025	2030	2035	2040	2045	2050
Total Workers	Manhattan	2,307,157	2,328,757	2,385,563	2,434,457	2,463,304	2,493,676	2,529,701	2,577,187	2,628,942	2,678,880
	Bronx	359,590	375,021	386,602	395,983	402,691	408,932	415,450	424,008	431,890	440,105
	Brooklyn	781,853	832,948	865,015	882,871	895,603	906,812	921,299	939,013	956,433	973,890
	Queens	677,897	703,651	727,383	737,820	741,706	745,775	751,479	760,690	766,015	772,093
	Staten Is.	120,649	133,416	138,586	140,331	142,683	144,281	145,922	148,035	150,056	152,061
	NYC	4,247,146	4,373,793	4,503,150	4,591,461	4,645,987	4,699,475	4,763,850	4,848,932	4,933,336	5,017,029

		2010	2012	2015	2020	2025	2030	2035	2040	2045	2050
Retail Workers	Manhattan	181,272	200,241	186,850	187,241	182,048	174,917	164,467	153,320	141,428	128,420
	Bronx	38,284	37,958	37,295	37,531	36,833	35,391	33,468	31,371	29,332	27,115
	Brooklyn	77,375	85,468	85,468	86,030	84,342	81,258	77,197	72,877	68,644	64,103
	Queens	68,599	69,904	67,782	68,343	66,939	64,207	60,853	57,167	53,605	49,826
	Staten Is.	16,240	16,785	15,970	15,963	15,740	15,175	14,356	13,458	12,550	11,568
	NYC	381,770	410,356	393,365	395,108	385,902	370,948	350,341	328,192	305,559	281,031

		2010	2012	2015	2020	2025	2030	2035	2040	2045	2050
Office Workers	Manhattan	962,410	965,835	1,026,583	1,044,531	1,058,723	1,069,409	1,088,425	1,116,056	1,151,933	1,187,134
	Bronx	41,239	47,538	45,950	46,659	47,771	48,411	49,672	51,104	53,170	55,202
	Brooklyn	118,140	133,241	146,521	149,233	152,787	155,127	159,565	164,684	171,515	178,296
	Queens	98,418	105,427	116,989	118,713	121,060	122,288	125,199	128,125	132,414	136,645
	Staten Is.	18,084	18,391	19,453	19,672	20,218	20,572	21,146	21,815	22,707	23,594
	NYC	1,238,291	1,270,432	1,355,495	1,378,808	1,400,559	1,415,808	1,444,007	1,481,784	1,531,739	1,580,871

2.6.2 2012 and 2015 Allocation of Total, Retail, and Office Employment

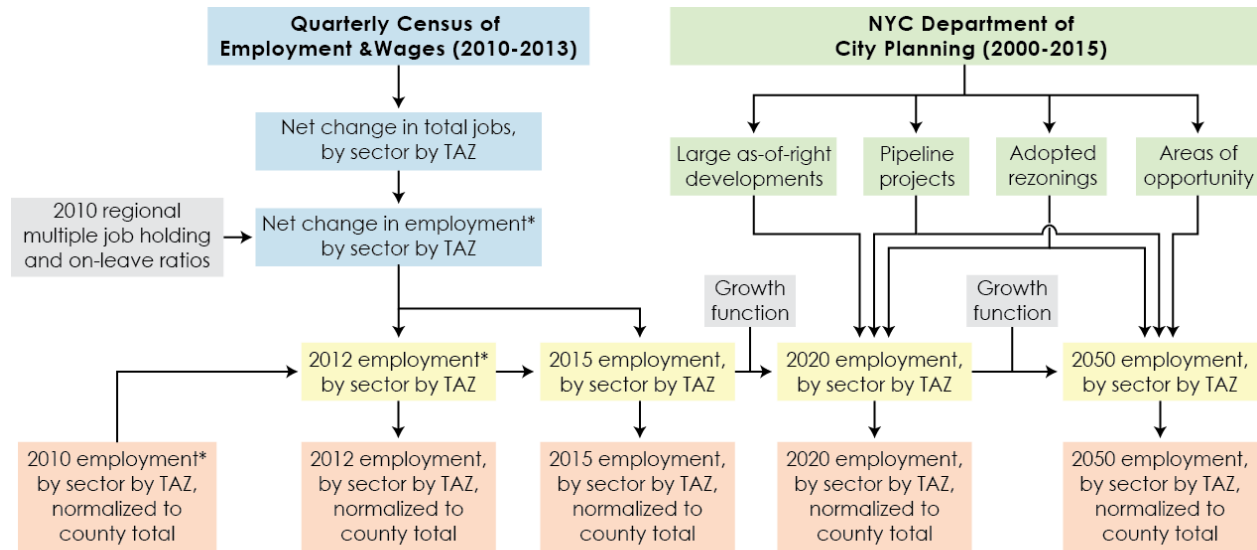
Historic data for number of firms and jobs are available for 2010 and 2013 from the QCEW. These datasets provide information on the number of jobs and industry classification for every employer in NYC who is required to file for unemployment coverage with the NYS Department of Labor. As explained previously, administrative data sources on employment such as QCEW and LEHD are limited in their capacity to capture the full universe of workers; therefore the QCEW data were only used to determine change in total jobs by TAZ from the 2010 baseline.

Confidential QCEW data for businesses located in NYC were geocoded to match businesses to the tax lot of their physical address, and then summed the number of total jobs, retail jobs and office jobs to the TAZ that they fall within. Change in total, retail and office jobs from 2010 (quarter 3) to 2013 (quarter 3) was calculated by TAZ. This increment in total number of jobs was then converted into a change in the number of workers in the allocation universe, defined as workers who reported to work sometime during the ACS reference week. This step also involved dividing the total number of jobs by the NYMTC region multiple job holding ratio and by the NYC ratio of workers on-leave for 2012.

To generate pre-normalized employment estimates by TAZ in 2012, half of the 2010 to 2013 QCEW increment of workers was added to the 2010 baseline for total, retail, and office employment. To

generate the 2015 estimates, the entire 2010-2013 increment in QCEW workers was added to the 2010 baseline¹⁹. A normalization process then adjusted these 2012 and 2015 estimates of total workers to ensure that the sum of a borough's TAZs was equal to the borough values of total, retail, and office workers shown in table 2-7.

FIGURE 2-12. EMPLOYMENT ALLOCATION



* Employment refers to the ACS definition, as workers 16+ who worked during the survey reference week.

2.6.3 Inputs to the 2020 and 2050 Employment Allocation

The allocation of total, retail and office employment for 2020 and 2050 was based largely on inputs from the borough planners on the potential for development. Changes in the number of workers were projected for each development in the data set by using a simple commercial square footage to worker conversion, specific to different commercial uses shown in the adjacent table. These are standard values used by DCP to project employment for EISs, and are slightly different from the conversions used in the non-NYC employment allocation. The net change of total, retail, and office workers for each project was divided into increments for two time periods: 2015-2020 and 2020-2050. The change in workers by time period and by sector was then aggregated to the TAZ geography, based on the spatial relationship between the project and the TAZ, described previously. The employment allocation model first calculated projected employment by TAZ for 2020 and 2050. Once the 2020 and 2050 allocations were completed, employment for 2025 through 2045 was linearly interpolated from 2020 to 2050 and then normalized to fit borough control projections for each interval.

¹⁹ $E_{2012} = E_{2010} + \frac{1}{2} (E_{2013} - E_{2010})$.
 $E_{2015} = E_{2010} + (E_{2013} - E_{2010})$.

TABLE 2-8. COMMERCIAL SQUARE FOOTAGE TO WORKER CONVERSION

Commercial use type	Square footage per worker
Office	250 sq ft
Retail	500 sq ft
Community facility	500 sq ft
Warehousing/industrial	1,000 sq ft

In addition to the borough planner outreach, a general growth function was applied to all TAZs in each borough. For total employment and office employment, which are not projected to decline, at the borough level, during the forecast horizon, this function computed general growth for each TAZ by raising existing 2010 employment to a power between 1.0001 and 1.02, depending on the borough and allocation year. The function equipped the employment model with the ability to allocate a greater share of general growth to those TAZs with existing high employment levels, based on the assumption held by land use experts at DCP that employment will grow at a higher rate in commercial centers in forecast years. For retail employment, which is projected to decline in all New York City counties throughout the forecast period, a percentage decrease was applied to all TAZs. This was based on the assumption that the loss of retail employment will be felt proportionally in commercial centers and local retail blocks alike.

2.6.4 2020 and 2050 Total and Office Employment Allocation

County-level total employment and office employment are projected to show monotonic growth throughout the forecast period in all NYC boroughs. For this reason, the employment model allocated these variables in a very similar fashion. For the 2020 and 2050 allocation, some combination of growth from the borough planner database and the general growth function was used to generate pre-normalized estimates of employment by TAZ. The amount used from each source was specific to each borough and time period, based on the relationship between the county control value to be allocated and the amount of data present in the borough planner database.

The exact mix of growth inputs used for each borough was generated iteratively and was informed in part on the “reasonableness” of the results. In some cases, such as Staten Island in 2020, anticipated employment from the borough planner dataset was very aggressive and resulted in a TAZ allocation for the borough that appeared uneven or required losses in certain TAZs so that the full projected growth could be accommodated. In those cases, only some portion of the full potential from the borough planner database was used. In other cases, such as Staten Island in 2050, anticipated employment from the borough planner database was very modest when compared to the borough projection for 2050. In such cases, a borough multiplier increased the amount of workers associated with those projects listed in the borough planner database. The borough multipliers for both, total and office employment, can be seen in the first section of Table 2-9.

TABLE 2-9. BOROUGH MULTIPLIER AND GENERAL GROWTH COMPONENT - TOTAL & OFFICE EMPLOYMENT

	Borough Planner Database Multiplier				General Growth Exponent			
	2015-2020		2020-2050		2015-2020		2020-2050	
	Total	Office	Total	Office	Total	Office	Total	Office
Borough								
Manhattan	1.00	1.00	1.00	0.92	1.0012	1.0005	1.0033	1.0003
Bronx	1.00	1.00	1.30	1.00	1.0005	1.0026	1.0081	1.0082
Brooklyn	1.00	0.90	1.00	1.35	1.0010	1.0003	1.0071	1.0131
Queens	1.00	0.87	0.80	1.35	1.0001	1.0002	1.0025	1.0108
Staten Island	0.92	0.86	1.12	1.50	1.0001	1.0002	1.0025	1.0123

In boroughs and time periods where the borough planner database did not provide ample projections of total and office employment tied to specific development and projects, the model relied heavily on the general growth function to boost employment numbers primarily in high employment TAZs. For the 2020 projection, the growth factor was applied to the 2015 estimates of total and office employment. The growth factor for the 2050 projection was applied to the 2020 estimates of employment. The table above shows that in the 2020 to 2050 period, a larger exponent was necessary to bring the TAZ employment estimates close to the borough total.

Total and office employment estimates by TAZ were calculated by summing the adjusted borough planner data and general growth factor for each TAZ for 2020 and 2050. Finally, a normalization procedure was run on the estimates for all interval years from 2020 to 2050 in order to fit the final TAZ projections into the borough employment totals.

2.6.5 2020 and 2050 Retail Employment Allocation

Allocating retail employment follows a similar approach as total and office employment, where a mix of general growth (which is negative, in the case of retail employment) and borough planner outreach were used to determine each TAZ's share of borough employment. As seen in Table 2-10, however, all NYC boroughs are projected to see declines in retail workers for every 5-year interval between 2020 and 2050, and only very modest growth, if any at all, between 2015 and 2020.

Since the nature of the borough planner database is to provide information on potential growth rather than natural declines resulting from macroeconomic forces, the multiplier applied to projected retail growth in the borough planner database is very low, ranging from 0.14 in Manhattan for 2020 to 0.55 in Queens in 2050. This model therefore makes the assumption that retail growth potential at various sites identified by borough planners will not be met in the future. This assumption is necessary to keep the pre-normalized TAZ estimates in line with the borough control totals.

Because of the modest changes in retail employment in the 2015 to 2020 period, the general growth factor was kept at 1 for all boroughs but Staten Island, meaning that existing levels of retail employment were unchanged in pre-normalized values from 2015 to 2020 in TAZs where no borough planner data were present. In Staten Island, which is projected to have negligible declines in retail employment from 2015 to 2020, only 99.5% of retail employment was maintained in TAZs where no borough planner data were present. Because of such steep declines in retail employment projections from 2020 to 2050 in all boroughs, the general growth multiplier was set to 80%.

TABLE 2-10. BOROUGH MULTIPLIER AND GENERAL GROWTH COMPONENT RETAIL EMPLOYMENT

<i>Borough</i>	Borough Planner Dataset Multiplier		General Growth Factor	
	<i>2015-2020</i>	<i>2020-2050</i>	<i>2015-2020</i>	<i>2020-2050</i>
	<i>Retail</i>	<i>Retail</i>	<i>Retail</i>	<i>Retail</i>
Manhattan	0.14	0.22	1.00	0.80
Bronx	0.17	0.33	1.00	0.80
Brooklyn	0.19	0.50	1.00	0.80
Queens	0.34	0.55	1.00	0.80
Staten Island	0.20	0.33	0.995	0.80

As with the total and office employment projections above, retail employment estimates by TAZ were calculated by summing the adjusted borough planner data and general growth factor for each TAZ for 2020 and 2050. Finally, a normalization procedure was run on retail estimates for all interval years from 2020 to 2050 in order to fit the final TAZ projections into the borough employment totals.

Linear interpolation was used to generate pre-normalized estimates for the interval years between 2020 and 2050. Next, the same normalization procedure explained above was used to fit the final TAZ projections into the borough employment totals.

2.6.6 Special TAZs

There were three special case TAZs in the allocation that were omitted from the above methodology: TAZ 163 (Liberty Island and portion of Ellis Island in New York), TAZ 3708 (Portion of Ellis Island in New Jersey), and TAZ 1343 (Riker's Island Correctional Facility). Employment was held constant in all three TAZs since, as isolated government employment centers, current employment levels are expected to remain constant during the forecast period.

2.7 Median Earnings per Worker

Median earnings per worker at the TAZ level were calculated using data from the 2006-2010 CTPP. Earnings data is only available by downloading tables indicating the number of workers in each tract whose earnings fall into a given range. There are ten data groups, shown below, which were then sent through a median calculator to generate an interpolated median for all workers in a TAZ.²⁰ The median earnings per worker were held constant for the entire forecast period (2010-2050) since it was considered unrealistic to project changes at such small geographies.

\$1 to \$9,999 or loss
\$10,000 to \$14,999
\$15,000 to \$24,999
\$25,000 to \$34,999
\$35,000 to \$49,999
\$50,000 to \$64,999
\$65,000 to \$74,999
\$75,000 to \$99,999
\$100,000 or more
No earnings in the past 12 months

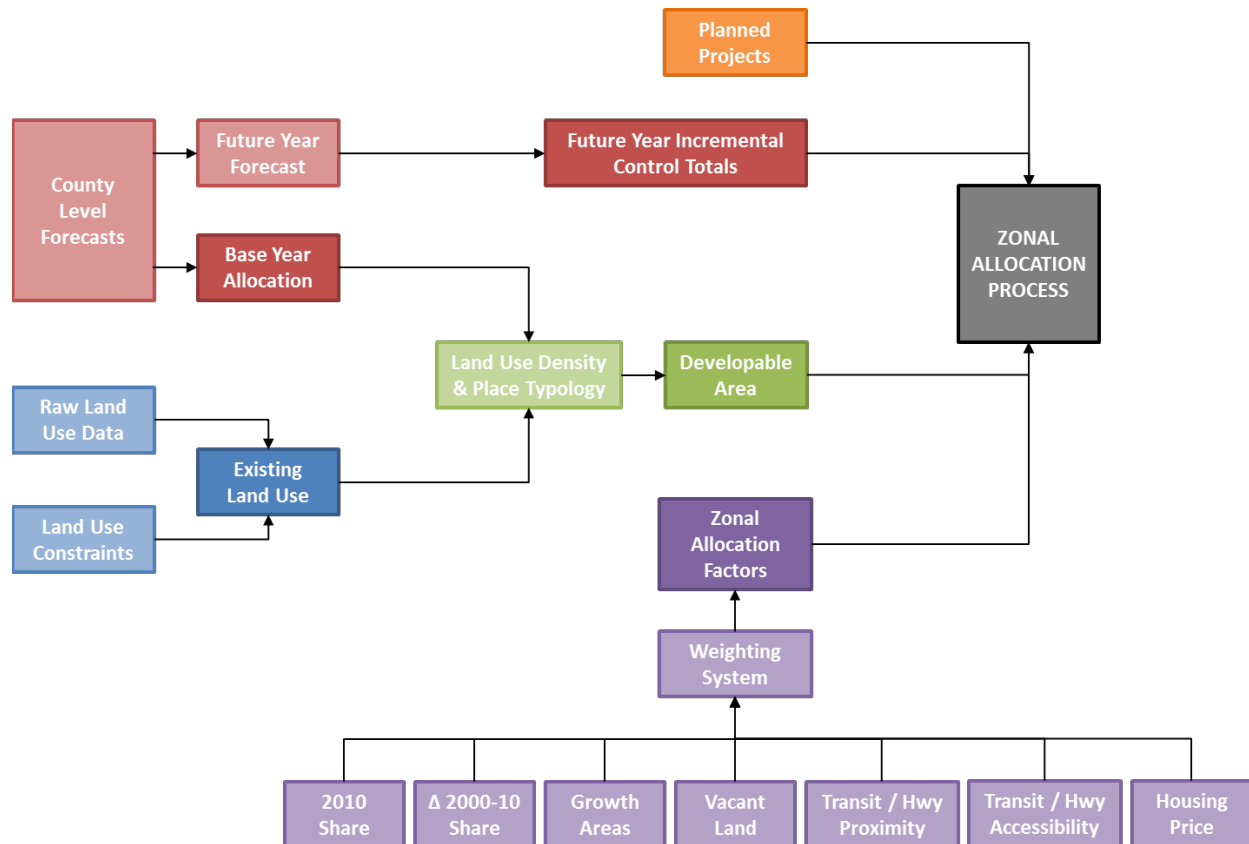
²⁰ For instances where census tracts were split among multiple TAZs, census block household data were used to determine which TAZ should be assigned the average household income. For instances where households are assigned to a TAZ, but no aggregate household income was available, the TAZ was assigned the average household income from an adjacent TAZ.

3.0 NON-NYC ALLOCATION PROCESS

3.1 Overview

Due to differences in county level forecast methodology, and data availability for smaller geographic areas required for the TAZ geographic level, a substantially different process was developed to conduct the TAZ allocation outside of NYC. Figure 3-1 presents a summary overview of methodological approach to developing TAZ level forecasts for the 23 counties outside of NYC.

FIGURE 3-1. SUMMARY OVERVIEW OF TAZ ALLOCATION PROCESS



As can be seen from Figure 3-1, there are five broadly distinct components that ultimately feed into the zonal allocation process.

- County level forecasts, base year allocation & future year controls.** County level forecasts provided the underlying basis for the down allocation to the zonal level, and provide the control totals (or controlling values in the case of variables such as average household size) that guide and define the zonal characteristics.

Block/tract-level estimates of base year population, households and employment were obtained from various sources such as U.S. Census Bureau, QCEW, LEHD, and ACS. These geocoded estimates that aggregated to base year county level figures were used as the seeding basis for the rest of the future zonal allocations.

The forecasts of population, households, and employment were used to generate incremental county-level control totals to be added to the base year zonal allocation.

- **Existing Land Use.** Data on existing land use was compiled and used to determine existing residential, commercial, restricted and vacant space in each TAZ. Combined with base year allocation data, this information provided estimates of existing land use densities in the various zones.
- **Developable Space.** The zonal allocation ensured that the incremental addition of future year growth in population, households and employment was conducted with due consideration of developable land availability. The ability for vacant developable space to carry future population, housing and employment growth was informed by anticipated future allowable density of development, and redevelopment potential.
- **Planned Projects.** TAZ level geocoded information of known housing or commercial development projects were provided by the various county planners and regional stakeholder agencies. This data was used to partially inform the spatial allocation of housing and employment in the future.
- **Zonal Allocation Factors.** The planned projects discussed above, only accounted for a small percentage of the zonal allocations of population, households and employment. The bulk of these variables were allocated using a single zonal allocation factor that rated the attractiveness of each zone in a county. The attractiveness of each zone, across multiple dimensions of desirability (as indicated at the bottom of Figure 3-1), was combined into a single factor based on the application of county-specific weights that rated the relative importance of each dimension of desirability.

3.2 Comparison to NYMTC's 2040 SED Zonal Allocation Process

The 2010 base year zonal allocation in the NYMTC's 2040 SED zonal allocation process was conducted in a very similar manner to that described in the introduction above. Following the base year allocation, future year county level forecasts of population, households and employment variables were then down-allocated using a process that involved two broad phases. First, growth was assigned to zones with major development projects. Following that initial allocation, additional incremental growth in each five year time interval of the forecast horizon was conducted based on the distributions observed in the 2010 base allocations, as well as the relative weight implied by the growth between 2000 and 2010.

As described, the previous zonal allocations approach shares some of the elements with the process outlined in Section 3.1 above. Specifically, the use of known or planned development projects; as well as the shares of base year (2010) and recent growth (2000-2010), as attraction measures of each zone in a given county. The 2050 process uses several more attractiveness measures as indicated in Figure 3-1.

More importantly, the current process takes into consideration existing land use and resulting estimates of vacant developable area and redevelopment potential. This land use assessment ties development potential to the availability of vacant developable area as a means to represent zonal constraints and limitations to growth.

With the exception of Rockland County where an explicit build out analysis was used to specify the residential capacity of each zone, the previous 2040 SED allocation process did not include a similar land use/capacity component, and instead relied on feedback from county planners to revise draft allocations. By incorporating the land use/capacity component in the current effort, the Project Team ensured land use capacity was addressed even in areas where such information from county planners may not have been available. This step also provided county planners more information to make their assessments of plausibility when providing feedback on draft allocations.

3.3 2050 Zonal Allocation Process Details

A more detailed description of the five broad elements of the current process introduced in Section 3.1 is provided in this section of the memorandum, together with a detailed discussion of the mechanics and sequence of the actual zonal allocation process within the allocation model.

3.3.1 County Level Forecasts, Base Year Allocation and Future Year Controls

County level forecasts provided the control totals (or controlling values in the case of variables such as average household size) that guided the zonal allocation process. The county level forecasts provided the base year control total, as well as the incremental change in subsequent years of the forecast horizon that would be added to the base year allocation. The county level forecasts are detailed and discussed in Technical Memorandum 4: 2050 SED County Level Forecast Results & Analysis.

The 2010 base year TAZ allocation was generated by aggregating block/tract-level counts of base year population, households and employment were obtained from various sources such as U.S. Census Bureau, QCEW, LEHD, and ACS. These geocoded estimates that aggregated to base year county level figures were used as the seeding basis for the rest of the future zonal allocations.

For population related variables – total population, household population, group quarter population (all categories presented in Table 1-1), and households – block level data from the US Census was compiled and aggregated up to the census tract and ultimately NYMTC TAZ geography based on correspondence tables that mapped overlapping areas.

For employment related variables (total, retail, and office employment), the approach taken to develop the base year zonal allocation was identical to that described in Section 2.6. It should be noted that even though the employment variables previously described only represent workers who commuted to their place of work, an allocation of total employment (jobs) was also developed using the same zonal distribution pattern observed for total employment of commuting workers.

The validated 2010 base year zonal allocation was used as the underlying basis for the zonal allocation process. Using the county level forecasts described above, the incremental control totals implied by changes in the future year forecasts were derived and would form the basis for further adjustments to the base year zonal allocation.

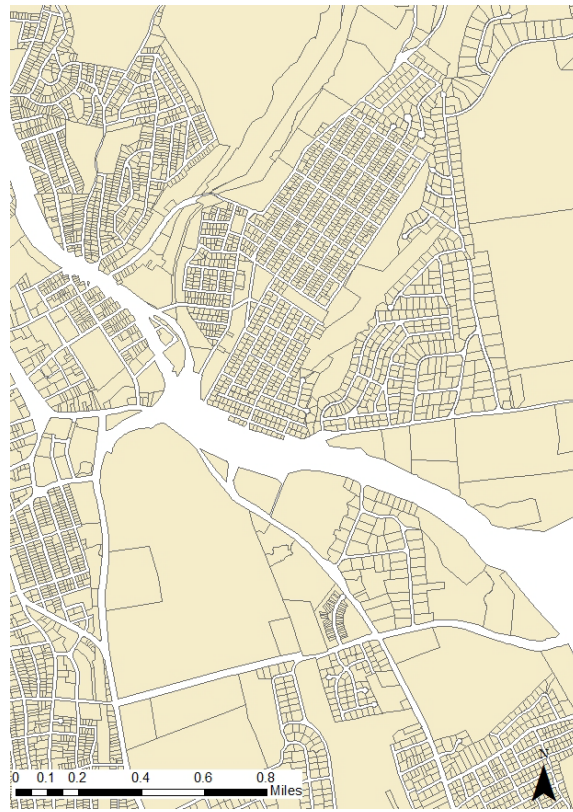
3.3.2 Existing Land Use

The location of future regional growth has to be subject to the availability of vacant developable land. Data on existing land use was compiled and used to determine existing residential, commercial, restricted and vacant space in each TAZ. The final product of this effort was a comprehensive land use inventory, by TAZ, that provides insight into potential development based on current land use attributes, as well as potential constraints. Combined with base year allocation data, this information provided estimates of existing land use densities in the various zones.

3.3.2.1 New York and New Jersey

In areas outside of the New York City Boroughs LBG collected parcel level land use data as well as other environmental land use data to derive a comprehensive geodatabase of the forecasting region's land use. Although this approach is intuitive, in practical terms the differences between jurisdiction's definitions of land use, and their growth constraints make a consistent approach difficult as different towns, villages, and municipalities all have varied approaches to defining land and zoning. Figure 3-2 provides an example of mapped parcel data that formed the basis of the existing land use analysis.

FIGURE 3-2. PARCEL LEVEL DATA EXAMPLE



As can be seen from Figure 3-2, the parcel data goes down to very fine level granularity. It should also be noted that the road right-of-ways are excluded from the accounting of existing land use as these areas are not likely to be available for future development or redevelopment.

To create a more unified set of data, parcel level data in New York State²¹ was used that included the Tax Assessor Property Class Coding system²². This system categorizes land based on a detailed assessment of how the land is being used. Table 3-1 presents the general categories for the code system. Using this code system as a basis for land use provides a transparent definitional system for the model's land use. However, the model requires a more aggregate land use definition that depends on basic assumptions.

²¹ This excludes Suffolk County which provided Parcel Based Land Use data that was predefined.

²² New York Tax Assessor Codes can be found at: http://www.tax.ny.gov/pdf/publications/orpts/manuals/vol6/rfv_propclasscodes.pdf

TABLE 3-1. NEW YORK STATE TAX ASSESSOR CODES (GENERAL CATEGORY)

Land Use Code	Category	General Description
100	Agricultural	Property used for the production of crops or livestock.
200	Residential	Property used for human habitation. Living accommodations such as hotels, motels, and apartments are in the Commercial category - 400.
300	Vacant Land	Property that is not in use, is in temporary use, or lacks permanent improvement.
400	Commercial	Property used for the sale of goods and/or services.
500	Recreation & Entertainment	Property used by groups for recreation, amusement, or entertainment.
600	Community Services	Property used for the well-being of the community.
700	Industrial	Property used for the production and fabrication of durable and nondurable man-made goods.
800	Public Services	Property used to provide services to the general public.
900	Wild, Forested, Conservation Lands & Public Parks	Reforested lands, preserves, and private hunting and fishing clubs

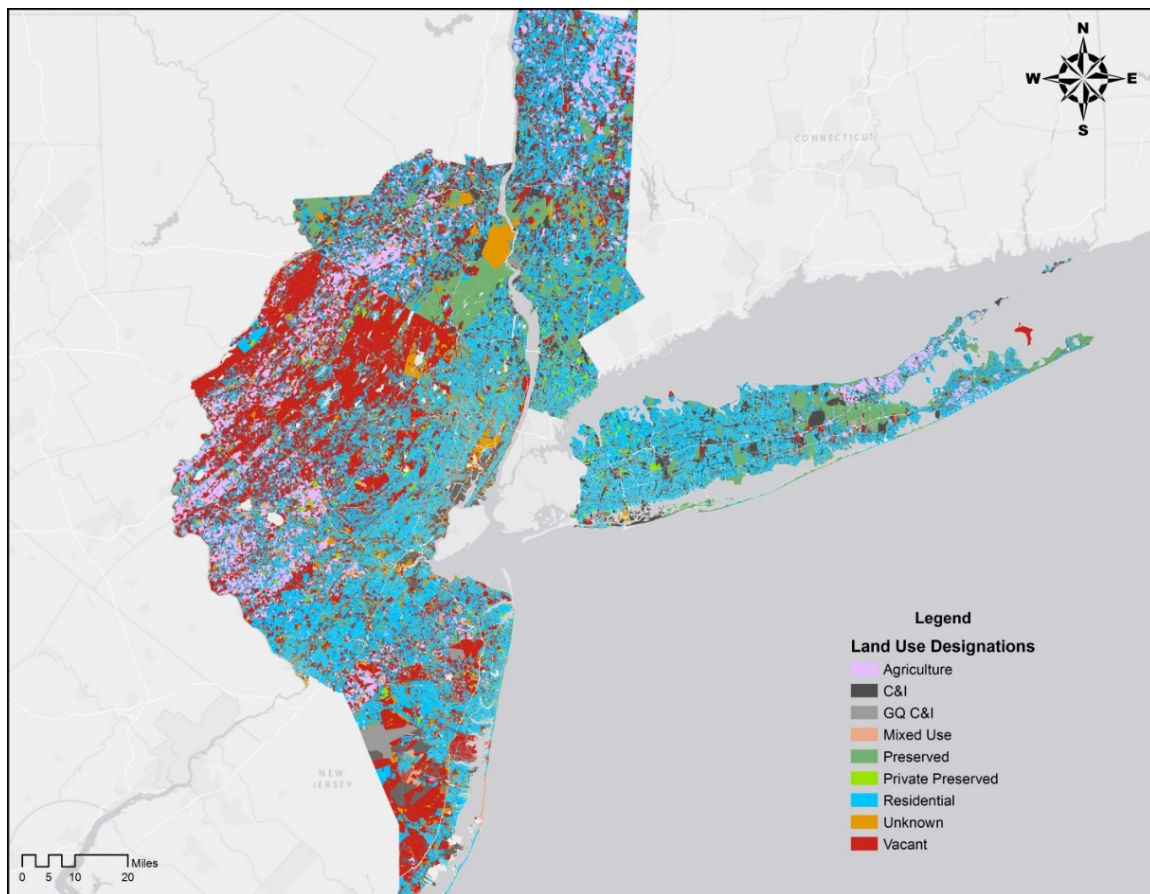
The basic assumptions used in the allocation model are as follows:

- Residential land includes all land uses that have permanent residents. This includes apartments and trailer parks which are considered Commercial in the NYS tax based system.
- Commercial and Industrial (C&I) land use encompass land used primarily for employment generating activities. This may include Public Service, Community Service, and Recreational Service areas that include government offices, theme parks, and entertainment venues.
- To provide additional insight into Commercial and Industrial land use, a sub-group of Group Quarters Commercial and Industry (GC C&I) land use was created. This is defined by land uses that include prisons, colleges, old age homes and military facilities. This land use encompasses both group quarter living facilities and employment generating characteristics. For modeling purposes this group will be aggregated with the C&I land use.
- Preserved land in the model assumes all of the wild, forested and conserved land and includes parks and open spaces defined in the Community Services Category.
- Privately Preserved land is akin to the Preserved land however, the land is privately owned and is therefore not considered publicly preserved land like a park. This may include a private golf club or other privately controlled tracts of land that could at some future date be transferred to developers.

- Mixed Use land, although not explicitly defined by the NYS codes are a subset of Commercial land use category and include multi use lands (Coded as 480 in the system)
- Vacant lands are defined in the model as vacant in the NYS system. In addition agricultural lands are also considered vacant in recognition of their potential conversion to other uses (at owner's discretion). However, portions of vacant lands can have additional restrictions to development such as environmental and preservation efforts which is defined later in this section.
- Each county's land use was categorized as Residential, Preserved, Private Preserved (golf course and such), Agriculture, C&I, GC C&I, Mixed use, and Unknown. The Unknown classification may include properties that are undefined as they are currently being developed or land that is generally not labeled. In some counties, land use was not defined in terms of taxable land use. Instead, broad land use categories were used to define land. In cases where this existed, a rational bridge between the aggregate land use types used in the model and the county definition was developed.

In New Jersey (NJTPA region and Mercer County) the NJ Tax Assessor data at the parcel level is not accurate enough to provide a clear indication of how the owner is using the land. To supplement the parcel data New Jersey Department of Environmental Protection's (NJDEP) Land Use Land Cover data that provides a more specific land use definition was also used for classification. Figure 3-3 below presents the NY and NJ land use aggregations.

FIGURE 3-3. NEW YORK AND NEW JERSEY LAND USE AGGREGATIONS



3.3.2.2 Connecticut

Because a comprehensive land use file for Fairfield and New Haven counties was not available, two datasets were used to determine land use patterns in Connecticut: the National Land Cover Database (NLCD) and land use data provided by the South Western Regional Planning Agency (SWRPA).

The National Land Cover Database is a raster²³ file that provides a land cover classification scheme that has been applied consistently across all 50 states and Puerto Rico. The file was converted to polygons and land use categories were established. SWRPA, which covers 225 square miles in lower Fairfield County, produced a shapefile that contained ten land use designations that were aligned with those established in the remainder of the region. As the SWRPA land use data is the most reliable for current conditions, Louis Berger used the SWRPA data as a proxy to better align the NLCD data with current land use. The following steps briefly outline the process used to create a uniform land use layer for Fairfield and New Haven counties, based on the same land use categories developed for the rest of the 23 county region:

- The National Land Cover Database was converted from raster to polygon, and assigned TAZs with the following land use categories established: agricultural, preserved, R&C&I (residential, commercial, or industrial), vacant, and water. Table 3-2 below shows how the NLCD categories were converted from their original categories to interim categories. Note that there was not enough information in the NLCD database to break out the residential/commercial/industrial (R&C&I) into separate components, as is required for consistency with the remainder of the region. This is addressed in subsequent steps.

TABLE 3-2. NLCD & LBG LAND USE CATEGORIES

NLCD Category	LBG Interim Category
Open Water	Water
Developed, Open Space	Preserved
Developed, Low Intensity	R&C&I
Developed, Medium Intensity	R&C&I
Developed High Intensity	R&C&I
Barren Land (Rock/Sand/Clay)	Vacant
Deciduous Forest	Vacant
Evergreen Forest	Vacant
Mixed Forest	Vacant
Shrub/Scrub	Vacant
Grassland/Herbaceous	Vacant
Pasture/Hay	Agriculture
Cultivated Crops	Agriculture
Woody Wetlands	Preserved
Emergent Herbaceous Wetlands	Preserved

²³ Raster data, as opposed to vector data, consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as temperature. Rasters are digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps. See http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=What_is_raster_data%3F for more detail

- SWRPA's land use designations were re-labeled as the final land use designations as specified in Table 3-3 below.
- The updated SWRPA land use file was merged in GIS with the updated NLCD to establish the relationship between the SWRPA categories and the national land use categories. This relationship was used as a proxy to help categorize land use for the non-SWRPA portion of Connecticut into LBG's final categories. In order to act as a proxy land use designation for the non-SWRPA region, the Project Team first created five population density categories by TAZ that were used to ensure that the land use in the SWRPA region matched as closely as possible to the land use in the non-SWRPA region. The density categories were determined using 2010 census tract data for Connecticut. Each polygon in both the SWRPA region and non-SWRPA region, therefore, had a density category associated with it.

TABLE 3-3. SWRPA & LBG LAND USE CATEGORIES

SWRPA	LBG Final Category
Agricultural	Agricultural
Commercial	C&I
Industrial	C&I
Institutional/Governmental	C&I
Mixed	Mixed
Other/Vacant	Vacant
Park/Conservation/Recreation	Preserved
Residential	Residential
Transportation/Utilities/Communication	C&I
Water	Water

- For each density category, the square mileage for each interim category (Table 3-2) was distributed by the final category (Table 3-3). For example, in density category 5, the total square mileage of non-preserved R&C&I from the merged NCLD and SWRPA file (covering the SWRPA region only) is 6.3. Of those 6.3 square miles, 48% corresponds to non-preserved C&I and 47% to non-preserved residential, as per the final categories. Therefore, to establish the square mileage for each LBG final category by TAZ, the square mileage for each interim category for the non-SWRPA TAZs was multiplied by the aforementioned shares.
- The density category calculations described above were used to determine the final square mileage for each TAZ outside the SWRPA region. Those TAZs in the SWRPA region were assigned a square mileage by category based on the original SWRPA data.

3.3.2.3 Constrained Land

An additional descriptive layer of data was created to include constraints that could limit growth in several areas where various land use sensitivities would have to be considered. This descriptive layer includes; wetlands and environmentally sensitive areas, parklands, and other preservation efforts such as agricultural preservation programs that are not captured through land use definitions. To address potential flooding hazards in some of the local areas that have experienced significant flooding with recent storm events such as Hurricane Sandy, FEMA's Zone V flood maps were used to delineate areas that might be susceptible to significant flood risk and thereby limit growth potential. The Zone V

designation was selected as threshold for this consideration as it associated with high risk coastal areas that are of particular concern in the region.

Figure 3-4 maps the aggregation of the constrained areas described above. By overlaying this estimated constrained land layer over the existing land use categories displayed in Figure 3-3, the Project Team was able to calculate the proportion of each land use category that was also considered constrained as demonstrated in Table 3-4 that summarizes the land use designations at the county level.

FIGURE 3-4. NEW YORK & NEW JERSEY REGIONAL CONSTRAINED LAND

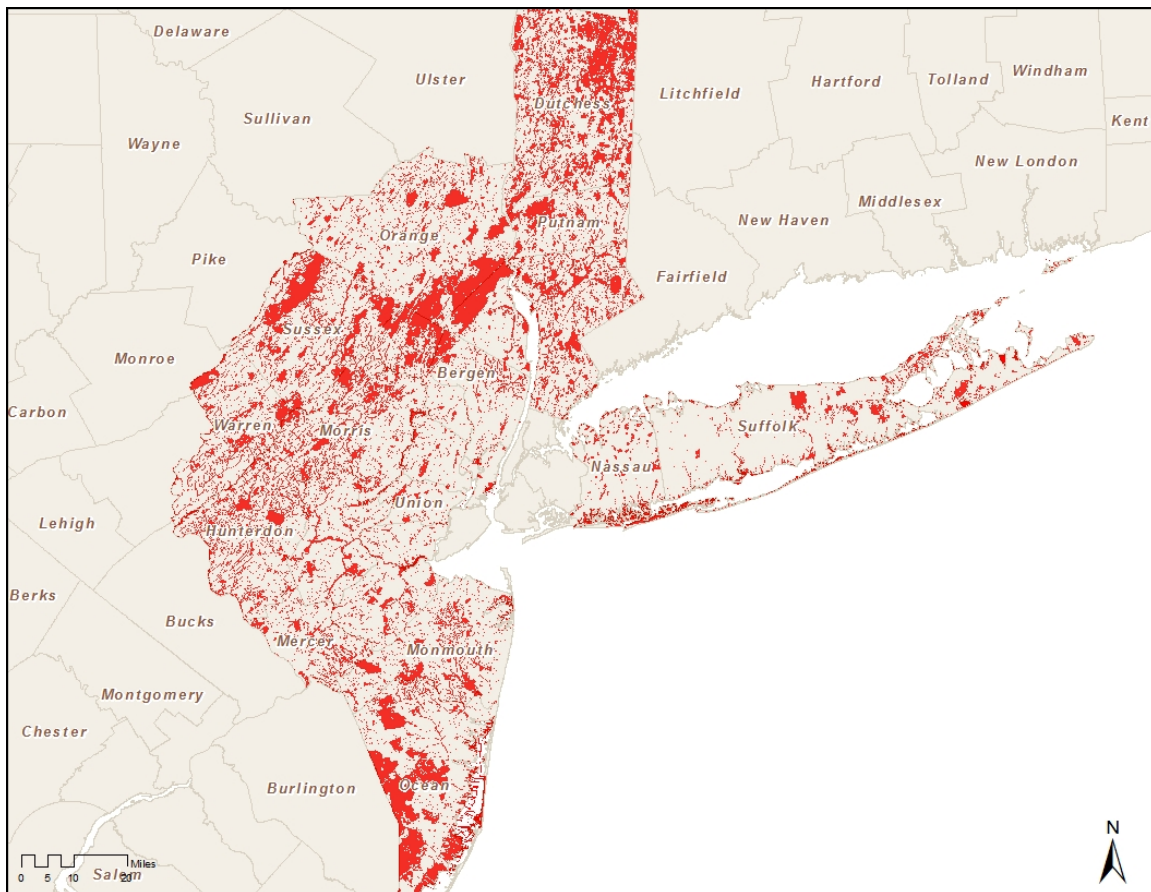


TABLE 3-4. SUMMARY OF LAND USE DESIGNATION IN SQUARE MILES, (CONSTRAINED LAND %)

	Agriculture	Comm. & Ind. (C&I)	Group Quarters (C&I)	Mixed Use	Preserved	Private Preserved	Residential	Unknown	Vacant	Water
Nassau	0.4 (8%)	58.6 (18%)	2.3 (3%)	2.7 (0%)	10.0 (60%)	12.2 (93%)	139.8 (1%)	4.6 (3%)	3.6 (30%)	0.0 (0%)
Suffolk	59.1 (35%)	130.7 (1%)	0.0 (0%)	0.0 (0%)	221.5 (20%)	0.0 (0%)	346.7 (2%)	0.0 (0%)	56.1 (6%)	24.9 (33%)
Dutchess	137.2 (93%)	67.0 (30%)	3.4 (36%)	1.9 (8%)	60.6 (63%)	3.0 (35%)	334.6 (24%)	0.0 (0%)	168.6 (25%)	0.1 (100%)
Orange	98.3 (13%)	68.4 (18%)	4.2 (23%)	0.5 (6%)	127.1 (73%)	1.8 (93%)	242.3 (8%)	84.4 (35%)	168.5 (15%)	0.6 (95%)
Putnam	3.3 (47%)	23.2 (15%)	0.1 (0%)	0.2 (0%)	48.4 (56%)	0.7 (0%)	79.8 (3%)	15.6 (20%)	57.8 (11%)	2.8 (0%)
Rockland	0.9 (26%)	21.8 (7%)	0.5 (4%)	0.3 (2%)	60.8 (88%)	4.0 (37%)	56.9 (1%)	0.3 (8%)	12.1 (9%)	5.8 (93%)
Westchester	6.0 (0%)	47.7 (0%)	3.0 (0%)	1.3 (0%)	99.6 (100%)	13.9 (100%)	196.6 (2%)	0.0 (0%)	42.2 (0%)	3.2 (100%)
Bergen	0.2 (25%)	31.2 (7%)	0.0 (0%)	1.7 (6%)	6.2 (38%)	2.7 (11%)	94.3 (7%)	23.8 (33%)	38.8 (48%)	2.3 (50%)
Essex	0.0 (7%)	20.9 (3%)	0.0 (0%)	2.0 (2%)	4.0 (49%)	2.5 (9%)	51.0 (2%)	3.6 (12%)	21.0 (48%)	2.1 (32%)
Hudson	0.0 (0%)	16.8 (4%)	0.0 (0%)	0.6 (0%)	1.8 (64%)	0.2 (1%)	9.9 (1%)	4.1 (8%)	3.2 (13%)	3.0 (39%)
Hunterdon	117.0 (19%)	9.6 (20%)	0.0 (0%)	13.7 (50%)	3.8 (32%)	2.7 (20%)	118.8 (17%)	14.9 (22%)	130.3 (34%)	9.9 (97%)
Mercer	8.7 (27%)	24.8 (22%)	0.1 (3%)	3.9 (39%)	1.7 (73%)	0.1 (37%)	131.8 (18%)	12.0 (40%)	23.8 (40%)	0.4 (77%)
Middlesex	2.8 (31%)	54.3 (11%)	0.0 (0%)	4.9 (29%)	2.1 (40%)	0.6 (21%)	160.0 (11%)	28.0 (17%)	22.4 (31%)	2.2 (56%)
Morris	16.4 (19%)	29.0 (13%)	0.0 (75%)	5.9 (30%)	6.2 (23%)	3.3 (19%)	133.5 (11%)	13.2 (25%)	232.8 (40%)	10.4 (37%)
Monmouth	41.9 (16%)	27.7 (8%)	5.6 (25%)	11.1 (49%)	9.6 (44%)	5.3 (21%)	167.7 (9%)	24.4 (24%)	131.4 (33%)	2.8 (66%)
Ocean	3.9 (60%)	74.9 (53%)	34.1 (5%)	15.9 (77%)	1.6 (46%)	3.8 (8%)	197.0 (17%)	35.3 (30%)	198.8 (55%)	23.8 (84%)
Passaic	0.4 (15%)	10.5 (6%)	0.0 (0%)	0.4 (7%)	2.0 (37%)	0.2 (20%)	36.4 (6%)	26.1 (34%)	95.0 (50%)	5.7 (49%)
Somerset	40.3 (22%)	19.6 (8%)	0.0 (0%)	8.7 (36%)	6.2 (42%)	5.6 (15%)	110.1 (7%)	19.8 (27%)	72.4 (29%)	0.3 (58%)
Sussex	67.3 (18%)	6.8 (16%)	0.0 (0%)	7.6 (47%)	2.3 (31%)	7.8 (30%)	87.1 (14%)	19.1 (28%)	311.2 (44%)	7.9 (67%)
Union	0.0 (52%)	20.4 (3%)	0.0 (0%)	1.3 (4%)	4.0 (56%)	1.9 (3%)	42.4 (2%)	3.0 (18%)	12.8 (54%)	0.5 (74%)
Warren	88.9 (13%)	6.7 (12%)	0.0 (0%)	5.2 (57%)	1.6 (13%)	2.2 (24%)	55.7 (13%)	12.1 (30%)	170.3 (32%)	7.0 (39%)
Fairfield	4.3 (5%)	90.1 (22%)	0.0 (0%)	1.0 (15%)	100.9 (66%)	0.0 (0%)	392.5 (9%)	0.0 (0%)	29.1 (15%)	25.0 (86%)
New Haven	4.7 (6%)	90.8 (22%)	0.0 (0%)	1.0 (14%)	96.2 (65%)	0.0 (0%)	377.8 (8%)	0.0 (0%)	28.3 (15%)	18.1 (82%)
TOTAL	701.9 (33%)	951.5 (17%)	53.4 (10%)	91.7 (43%)	878.2 (58%)	74.6 (49%)	3562.7 (10%)	344.2 (28%)	2030.4 (34%)	158.6 (66%)

Table 3-4 shows that several of the land use categories have significant proportions located in constrained areas. This observation comprised a critical component of the projection of future space available for growth and development.

3.3.3 Developable Space

The zonal allocation process was designed to ensure that the incremental addition of future year growth in population, households and employment was conducted with due consideration of available space for development. The space available for development was estimated using the existing land use designations as described in the previous section of the memorandum.

3.3.3.1 Existing Vacant Land

The initial estimate of potential developable space was calculated as the land area of unconstrained existing vacant land, plus the land area of unconstrained agricultural land (also in an unconstrained condition). The inclusion of existing agricultural land in this calculation reflects the potential for this space to be converted to other uses in the future.

3.3.3.2 Redevelopment Potential

The second component of future developable space was the redevelopment potential associated with other existing land uses. This process involved a number of intermediate steps described below.

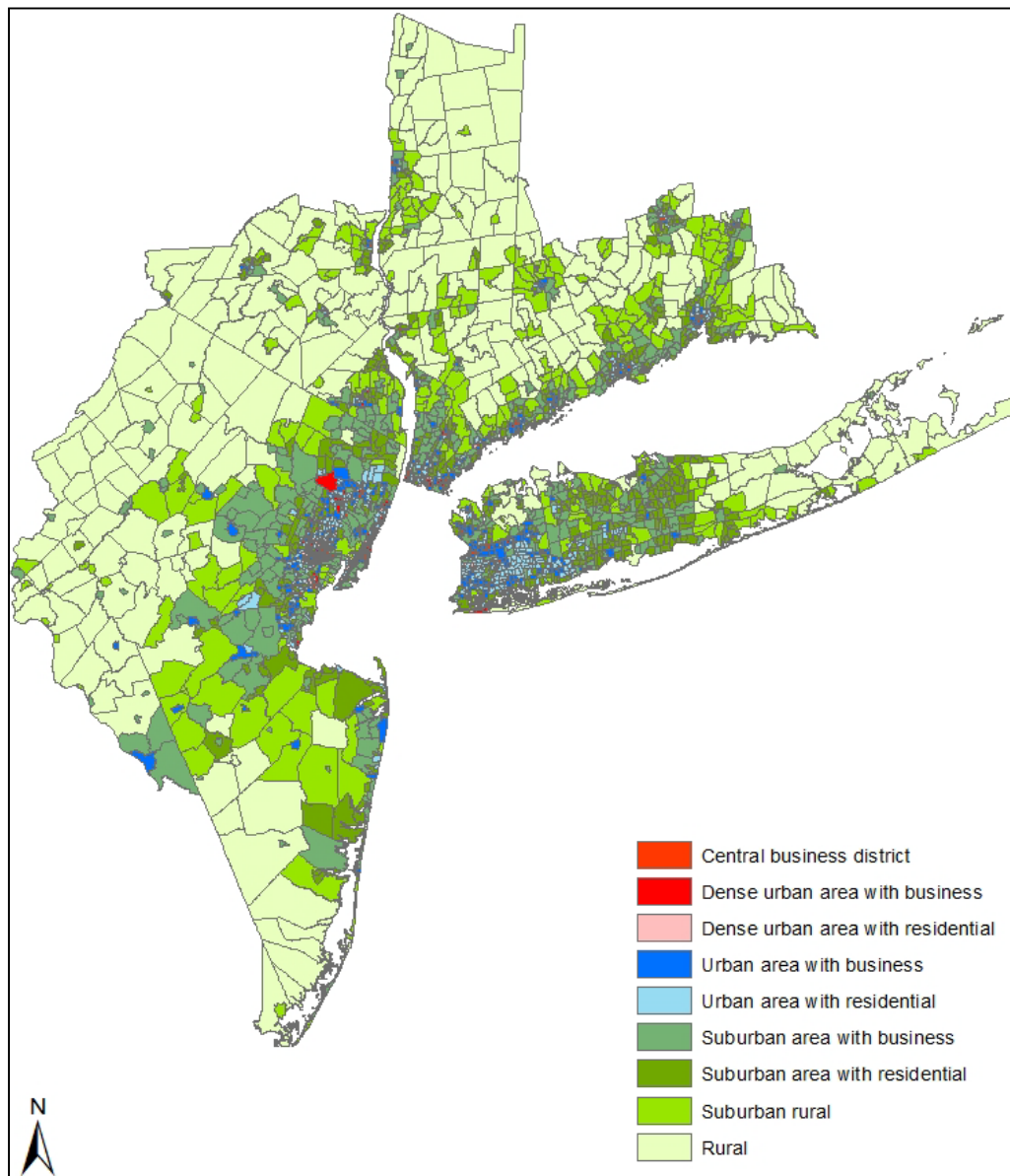
3.3.3.2.1 Place Typology

The first step in determining the redevelopment potential was the typological categorization of each TAZ based on levels of population and employment density. As indicated in Table 3-5, nine place typologies were defined based on various thresholds of combined population and employment density, as well as population and employment ratios. Figure 3-5 maps the resulting place typologies across the 23 counties outside NYC.

TABLE 3–5. PLACE TYPOLOGY DEFINITIONS & CORRESPONDING FUTURE DEVELOPMENT DENSITY INCREASES

	Typology	Pop. + Emp. Density	Pop / Emp Ratio	Future Development Density Increase						
				Unconstrained			Constrained			
				Residential	Commercial & Industrial	Unknown	Residential	Commercial & Industrial	Unknown	Vacant
1	Core Business District	> 25,000/mi ²	< 2	20%	30%	10%	10%	15%	5%	5%
2	Dense Urban Area w/ Business	> 25,000/mi ²	2 to 5	20%	30%	10%	10%	15%	5%	5%
3	Dense Urban Residential	> 25,000/mi ²	> 5	20%	30%	10%	10%	15%	5%	5%
4	Urban Area w/ Business	10,000-25,000/mi ²	< 3	20%	30%	10%	10%	15%	0%	5%
5	Urban Area Residential	10,000-25,000/mi ²	> 3	20%	30%	10%	10%	15%	0%	5%
6	Suburban Area w/ Business	2,500-10,000/mi ²	< 3	20%	30%	10%	10%	15%	0%	5%
7	Suburban Area Residential	2,500-10,000/mi ²	> 3	20%	30%	10%	10%	15%	0%	5%
8	Suburban-Rural	1,000-2,500/mi ²	NA	10%	15%	5%	5%	10%	0%	5%
9	Rural	< 1,000/mi ²	NA	5%	10%	0%	0%	5%	0%	0%

FIGURE 3-5. PLACE TYPOLOGY MAP



3.3.3.2.2 Future Density of Development

Based on the place typology designation, future increases in development density were assumed for the various land use categories as indicated by the columns on right hand side of Table 3-5. By assuming a higher density of future development for each of the land use types and constrained conditions in Table 3-5, the amount of developable area in each TAZ was effectively increased by the corresponding percentages presented in the table.

Developable area accruing to redevelopment potential was automatically calculated for all TAZs. However, based on FWG feedback some of the TAZs (predominately in New Jersey) were excluded from redevelopment potential consideration. Developable area in these TAZs was limited strictly to the initial estimates of vacant developable area. The resulting estimate of total developable area (including space accruing from

assumed redevelopment potential) is summarized in Table 3-6 – the table also provides the estimate accruing to redevelopment potential, as well as an estimate of the total area of each county for additional context.

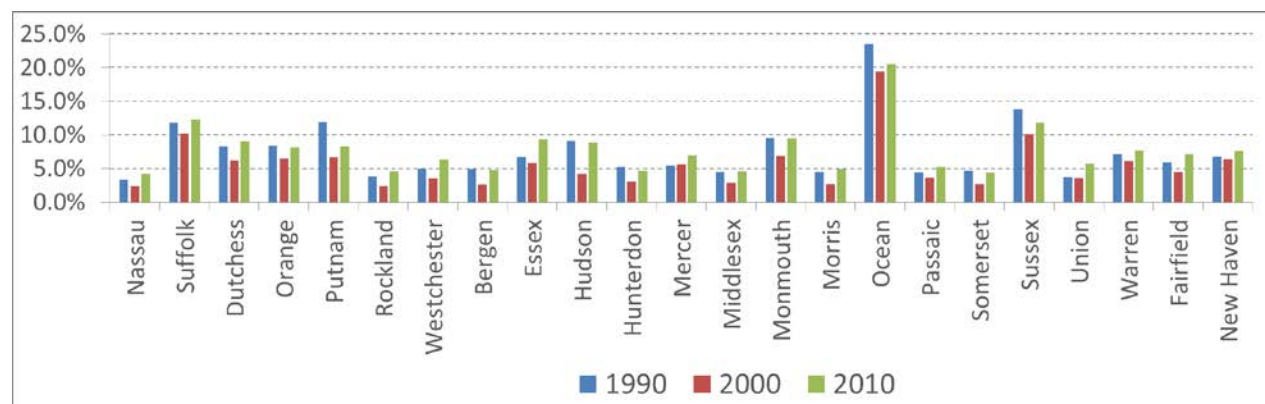
TABLE 3-6. DEVELOPABLE AREA ESTIMATE (SQUARE MILES)

County	Total Developable Area (SQM) by Place Typology Designation									Total	2010 Developable Space			TOTAL AREA
	1	2	3	4	5	6	7	8	9		Existing	Redevelop	Total	
Nassau	0.4	0.3	0.2	8.9	10.6	6.7	6.8	3.0	2.7	39.7	2.8	36.8	39.7	234.1
Suffolk	0.0	0.0	0.0	2.4	3.4	28.3	35.2	20.6	75.4	165.3	91.2	74.2	165.3	839.1
Dutchess	0.2	0.0	0.0	0.4	0.1	4.0	1.8	14.6	137.8	158.9	135.8	23.1	158.9	776.3
Orange	0.1	0.0	0.0	0.8	0.5	6.3	5.3	20.2	218.8	252.0	228.8	23.3	252.0	796.0
Putnam	0.0	0.0	0.0	0.0	0.0	0.0	0.9	10.8	48.8	60.5	53.0	7.5	60.5	231.8
Rockland	0.0	0.2	0.0	0.9	0.7	7.8	4.6	6.1	5.1	25.3	11.6	13.6	25.3	163.4
Westchester	0.6	0.6	0.7	2.8	2.5	13.9	7.8	16.1	35.6	80.6	48.2	32.5	80.6	413.4
Bergen	0.2	0.3	0.3	3.1	4.1	16.5	11.0	8.4	4.2	48.1	20.5	27.6	48.1	201.3
Essex	0.7	0.6	1.5	2.3	2.6	11.9	4.8	1.5	0.0	26.0	11.0	15.0	26.0	107.0
Hudson	0.7	0.9	1.2	1.4	1.0	3.1	0.3	0.9	0.0	9.7	2.8	7.0	9.7	39.7
Hunterdon	0.0	0.0	0.0	0.3	0.0	0.8	0.0	3.3	184.4	188.7	181.6	7.1	188.7	420.6
Mercer	0.0	0.0	0.0	2.1	0.0	21.1	4.3	16.8	20.8	65.0	20.5	44.4	65.0	207.3
Middlesex	0.0	0.1	0.1	2.5	1.4	28.7	8.2	36.0	2.0	79.0	17.5	61.5	79.0	277.2
Monmouth	0.0	0.0	0.0	1.8	0.6	11.2	17.1	65.1	57.2	153.1	122.6	30.5	153.1	427.4
Morris	0.0	0.0	0.0	1.4	0.0	33.1	0.9	49.0	91.9	176.3	153.4	23.0	176.3	450.8
Ocean	0.0	0.0	0.0	0.1	0.0	25.8	19.1	13.0	149.9	207.9	90.4	117.5	207.9	589.0
Passaic	0.0	1.7	0.1	1.0	0.7	9.7	2.4	2.1	39.4	57.0	47.7	9.4	57.0	176.7
Somerset	0.0	0.0	0.0	0.5	0.5	9.6	0.9	44.4	43.8	99.5	82.8	16.7	99.5	283.0
Sussex	0.0	0.0	0.0	0.0	0.0	3.3	0.0	8.9	223.9	236.0	230.3	5.7	236.0	517.0
Union	0.2	0.5	0.4	2.2	3.7	10.6	4.3	2.1	0.0	24.0	5.8	18.1	24.0	86.3
Warren	0.0	0.0	0.0	0.0	0.0	2.0	0.6	3.6	191.2	197.3	192.9	4.4	197.3	349.7
Fairfield	0.4	0.1	0.1	3.1	2.0	14.1	7.5	39.2	28.8	95.3	28.8	66.5	95.3	643.0
New Haven	0.4	0.0	0.0	1.3	1.8	15.1	11.2	33.2	29.2	92.1	28.7	63.4	92.1	616.9
Total	4.0	5.5	4.7	39.0	36.2	283.1	155.2	418.7	1590.9	2537.2	1808.6	728.7	2537.2	8847.2

3.3.3.3 Existing Vacant Housing

The amount of vacant housing available to absorb some of the growth in households and corresponding populations was the final consideration in the assessment of the developable space available. Based on data obtained from the US Census, the Project Team calculated housing vacancy rates for 1990, 2000, and 2010. The resulting housing vacancy rates for the 23 counties are presented in Figure 3-6 and clearly show that vacancy rates in the region fell between 1990 and 2000, and climbed once again in 2010 – probably as a result of the effects of the ‘Great Recession’ that resulted in part due to the subprime mortgage crisis that saw increased foreclosures across the nation.

FIGURE 3-6. HOUSING VACANCY RATES



Given the harsh economic conditions experienced during the Great Recession, the current economic recovery already underway across the country, and the rebounding housing market in the New York

Metropolitan region, the Project Team relied on the 2000 housing vacancies as a more appropriate assumption of future housing vacancy rates. Using this housing vacancy assumption, the zonal housing vacancy rate was adjusted by the appropriate county factors reflected in the fourth column of Table 3-7.

Table 3-7 shows that of the 419,509 vacant housing units existing in the 23 non-NYC counties in 2010, 117,755 were now considered as available to absorb growth in households (as shown by the last column on the right) without additional utilization of existing vacant developable space.

TABLE 3-7. HOUSING VACANCY RATE ASSUMPTIONS & IMPACTS ON DEVELOPABLE SPACE

County	Vacancy Rates			2010 Housing Units		
	2010	2000	Adjust.	Total	Vacant	Available
Nassau	4.2%	2.3%	55.5%	468,346	19,818	8,814
Suffolk	12.3%	10.2%	82.6%	569,985	70,063	12,201
Dutchess	9.0%	6.2%	68.8%	118,638	10,673	3,330
Orange	8.1%	6.5%	80.1%	137,025	11,100	2,208
Putnam	8.3%	6.6%	79.8%	38,224	3,183	644
Rockland	4.6%	2.4%	52.3%	104,057	4,815	2,297
Westchester	6.4%	3.5%	55.3%	370,821	23,589	10,533
Bergen	4.7%	2.6%	56.0%	352,388	16,658	7,322
Essex	9.3%	5.7%	61.4%	312,954	29,242	11,282
Hudson	8.8%	4.2%	47.4%	270,335	23,898	12,582
Hunterdon	4.7%	3.0%	64.2%	49,487	2,318	830
Mercer	7.0%	5.6%	80.2%	143,166	10,014	1,987
Middlesex	4.6%	2.9%	61.9%	294,800	13,614	5,187
Monmouth	9.5%	6.9%	73.1%	258,413	24,427	6,568
Morris	4.9%	2.7%	54.6%	189,842	9,308	4,226
Ocean	20.5%	19.4%	94.8%	278,052	56,941	2,933
Passaic	5.2%	3.6%	69.8%	175,966	9,181	2,774
Somerset	4.4%	2.7%	62.2%	123,127	5,368	2,028
Sussex	11.8%	10.1%	85.6%	62,057	7,305	1,051
Union	5.7%	3.5%	62.0%	199,489	11,371	4,319
Warren	7.7%	6.1%	79.1%	44,925	3,445	719
Fairfield	7.1%	4.5%	63.1%	361,221	25,676	9,466
New Haven	7.6%	6.4%	83.8%	362,004	27,502	4,456
Total				5,285,322	419,509	117,755

3.3.4 Planned Projects

Known projects in the pipeline for future development comprised another key component of the TAZ allocation process. The Project Team in close coordination with local county planners and other stakeholders represented in the FWG developed an inventory of planned projects that were expected to

be implemented within the forecast horizon. As such, this information provided a good indication of where future growth was expected to occur based on market factors and zoning regulations (particularly in the near term 2010-2025).

The development inventory included information on the projects location (geocoded to a specific TAZ), such as the number of residential housing units, and the floor space associated with various uses such as office, other commercial (including retail), industrial, institutional, and other non-residential. Floor space was converted into an estimate of anticipated jobs based on conversion factors presented in Table 3-8.

TABLE 3-8. COMMERCIAL SPACE TO EMPLOYMENT CONVERSION FACTORS

Commercial Use Type	Square Footage to Worker
Office (Outside of Manhattan)	300
Other Commercial (incl. Retail)	500
Industrial	400
Institutional	500
Other Non-Residential	600

The development inventory was therefore used to project where future housing units and employment were anticipated to be located at the TAZ level. Table 3-9 provides a county-level summary estimate of the total housing units and jobs obtained from the development inventory.

TABLE 3-9. DEVELOPMENT INVENTORY HOUSING UNITS AND TOTAL EMPLOYMENT

	Housing Units									Total Employment								
	2015	2020	2025	2030	2035	2040	2045	2050	2015-50	2015	2020	2025	2030	2035	2040	2045	2050	2015-50
Nassau	5,686	7,346	0	0	0	0	0	0	13,032	5,185	3,324	0	0	0	0	0	0	8,509
Suffolk	3,241	9,516	1,735	4,779	0	2,000	0	0	21,271	4,131	12,340	7,343	7,987	0	3,850	0	0	35,652
Dutchess	1,598	1,471	4,270	2,704	865	0	0	0	10,908	1,318	2,276	3,122	7,580	371	0	0	0	14,667
Orange	0	427	0	0	0	0	0	0	427	170	3,441	271	309	253	258	258	258	5,218
Putnam	300	1,153	0	0	0	0	0	0	1,453	0	396	2,462	0	0	0	0	0	2,858
Rockland	254	2,952	0	0	0	0	0	0	3,206	8,855	12,813	0	0	0	0	0	0	21,668
Westchester	1,906	12,111	2,153	903	111	1,196	881	0	19,261	1,795	17,315	1,255	1,784	100	80	69	0	22,398
Bergen	0	0	0	0	0	0	0	0	0	0	12,000	0	0	0	0	0	0	12,000
Essex	0	310	300	0	0	0	0	0	610	1,285	2,559	3,372	4,064	2,463	1,384	1,359	1,334	17,820
Hudson	0	8,274	7,925	0	0	0	0	0	16,199	638	5,420	5,512	5,286	5,261	5,238	158	158	27,671
Hunterdon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mercer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Middlesex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monmouth	0	0	0	0	0	0	0	0	0	0	3,900	0	0	0	0	0	0	3,900
Morris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ocean	0	5,000	5,000	0	0	0	0	0	10,000	0	0	0	0	0	0	0	0	0
Passaic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Somerset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sussex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Union	0	0	0	0	0	0	0	0	0	810	795	1,388	1,332	1,064	857	854	852	7,951
Warren	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fairfield	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New Haven	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	12,985	48,560	21,383	8,386	976	3,196	881	0	96,367	24,187	76,581	24,725	28,341	9,512	11,667	2,697	2,602	180,312

3.3.5 Allocation Factors

The known projects discussed above, only accounted for a small percentage of the zonal allocations of population, households and employment. The bulk of these variables were allocated using a single zonal allocation factor that rated the attractiveness of each zone in a county. The attractiveness of each zone, across multiple dimensions of desirability, was combined into a single factor based on the application of county-specific weights that rated the relative importance of each dimension of desirability.

The allocation factors were first used to allocate total jobs down to the zonal level, before the subsequent allocation of total, retail, and office employment (in terms of commuting workers) was performed by replicating the same pattern of total jobs. Similarly, allocation factors were used to first allocate housing units and households before corresponding household population estimates were attached to the zonal pattern of household distributions by applying the appropriate average household size factors by county.

Zonal allocation factors were derived to represent the attractiveness of each zone in a given county based on the following considerations:

- 2010 TAZ share of county's households/employment
- Share of recent growth
- Vacant land
- Priority growth areas
- Proximity to highway/transit corridors
- Highway/transit accessibility
- Housing price (households only)

3.3.5.1 2010 TAZ Share of County's Households/Employment

Following the 2010 base year zonal allocation described in Section 3.3.1, the resulting zonal distribution of households and employment was used to calculate a zonal preference represented in percentage terms. This dimension of zonal attraction reflects the existing patterns of county settlement and are therefore assumed to represent historical preference of zonal location.

3.3.5.2 Share of Recent Growth

Also following the 2010 base year zonal allocation, a similar effort to allocate the 2000 households was conducted and thereby allowed the estimation of zonal share of recent growth. Similar to the 2010 share measure described above, this dimension of zonal attraction also reflects a historical preference of zonal location. However, it may also account for recent shifts in long term historical preferences in response to various factors such as personal tastes, local zoning changes, capacity limits, and county plans to emphasize certain areas as development priorities.

It should be noted that in the calculation of the share of recent employment growth, a 2002 starting year was used instead of 2000 as this was required for consistency with LEHD based data used to develop the 2010 base year employment estimates.

3.3.5.3 Vacant Land

In recognition that future growth and development will be attracted to zones with minimal impediments to development, existing vacant land was identified as another dimension for consideration in the zonal allocation factors. The zonal estimates of existing vacant land (as described in Section 3.3.2) were used to calculate the zonal distribution of each county's vacant land in percentage terms.

3.3.5.4 Priority Growth Areas

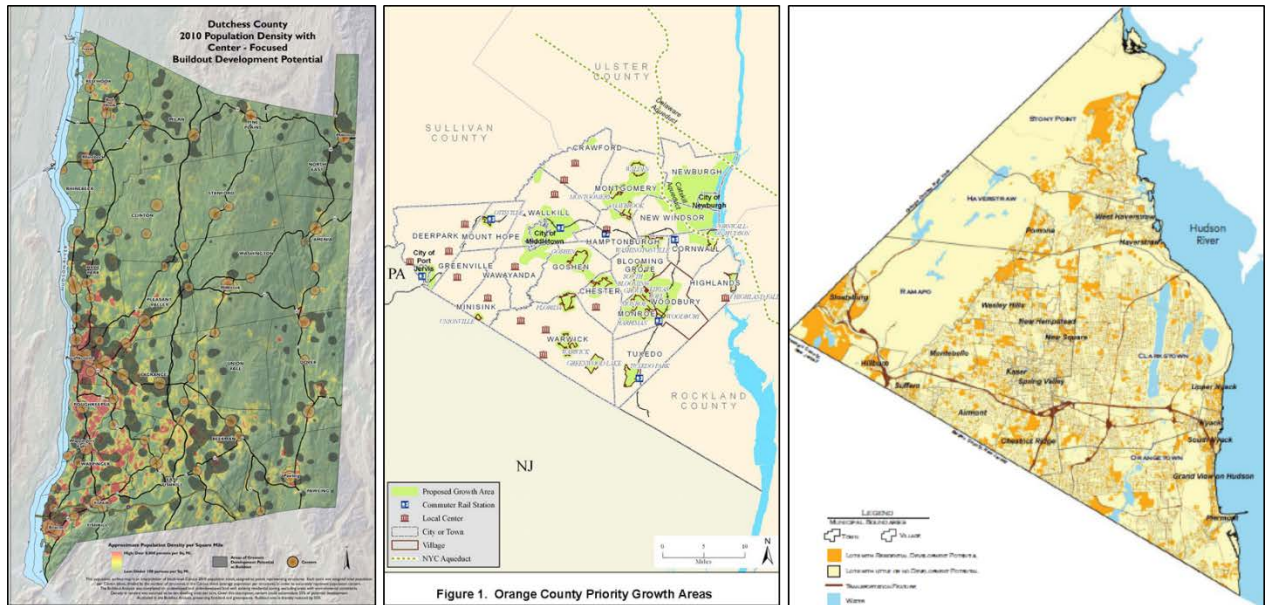
Because some TAZs in the region are expected to grow faster due to specific emphasis resulting from targeted strategies such as transit-oriented development (TOD), smart growth programs etc., the Project Team also developed an attraction measure designed to reflect these anticipated concentrations of development activity.

Priority growth areas in New Jersey were obtained from mapped locations of the Smart Growth Area program. The Project Team also previously met with county planners from the Long Island and Mid-

Hudson subregions to review current and future plans and overall views of development in their jurisdictions. The county planners provided insights into where future development will occur and what may propel future growth in the subcounty areas.

Supplemental studies such as county comprehensive plans and water network master plans were also reviewed. If any mapping was presented in the reports, the Project Team incorporated them into the BPM TAZ structure to represent the growth areas locations. Figure 3-7 below presents examples of maps obtained from Dutchess, Orange and Rockland counties that show priority growth areas as shaded portions of each map.

FIGURE 3-7. EXAMPLES OF COUNTY MAPPED PRIORITY GROWTH AREAS (DUTCHESS, ORANGE, ROCKLAND)

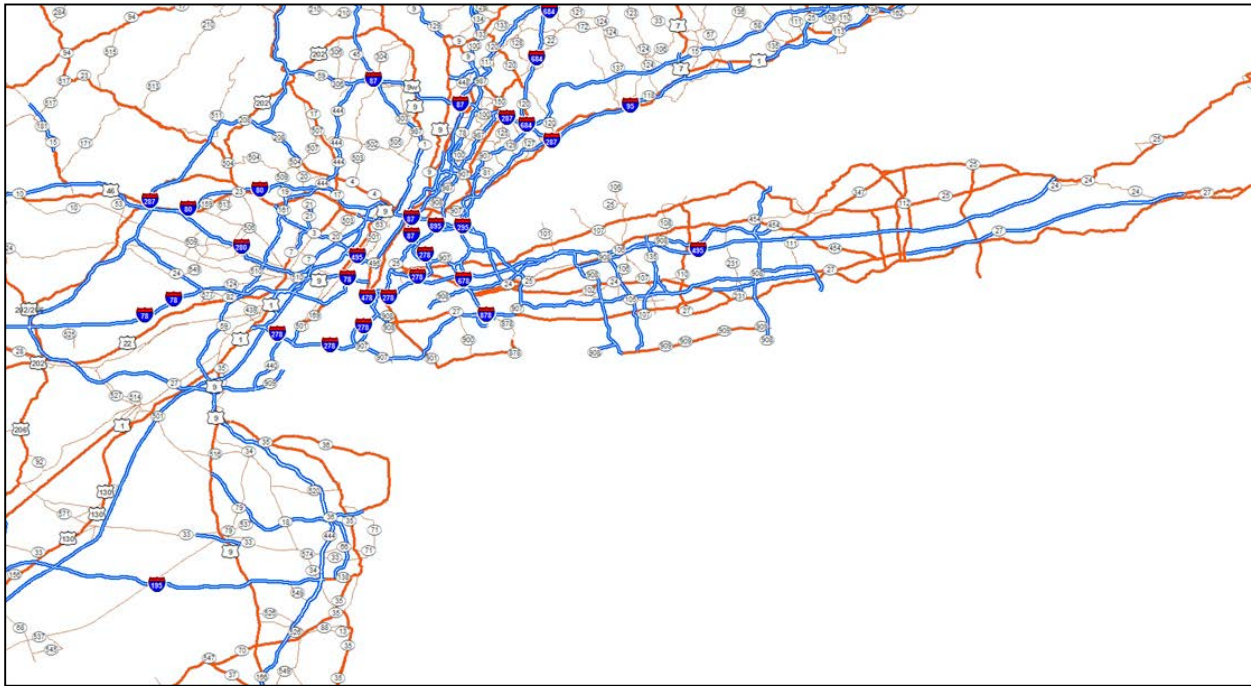


Once the zones in each county had been categorized as either a priority growth area or not, the Project Team weighted each priority growth TAZ to be four times more attractive as a non-priority growth TAZ. This relative weighting was converted into zonal attraction factors in percentage terms by dividing the assigned priority growth area weight of each zone, by the total priority growth weights of all zones in the county.

3.3.5.5 Proximity to Highway and Transit Corridors

The proximity to a major highway corridor was also considered as another dimension of zonal attraction given the often observed pattern of population settlements along major highway corridors. Using ESRI's Street Dataset, the Project Team mapped major roadways (limited access and major highways as indicated by the blue and orange roadways in Figure 3-8) running through the 23 counties to determine the linear miles crossing through each TAZ.

FIGURE 3-8. EXAMPLE OF MAJOR HIGHWAY CORRIDORS



The allocation factor used to represent this measure was developed using a combination of two approaches. First, a simple allocation factor was developed that compared each TAZ in terms of the number of major highway crossings observed. However, this simple ratio had the potential bias towards larger TAZs that, due to their size, may have a greater likelihood of containing major highways (particularly in more rural areas). Table 3-10 provides an example of this calculation conducted for Putnam County.

To ensure that this measure did not create a bias towards more rural TAZs, the Project Team calculated a second allocation factor that normalized the highway miles calculated for each TAZ by dividing by the TAZ's area in square miles. The resulting highway miles per square mile were then used to develop a second allocation factor that controlled for TAZ size as also demonstrated in Table 3-10.

A final highway proximity allocation factor was obtained by averaging the two allocation factors as shown by the last column in Table 3-10.

Given that transit stations are often located near, or are the focus of development activity, the Project Team developed an attraction measure similar to the highway corridor proximity variable described above. The total number of train stations in each zone was divided by the total number of train stations in the entire county to derive a factor representing the relative attractiveness of each zone according to this measure.

TABLE 3-10. SAMPLE CALCULATION OF HIGHWAY PROXIMITY ALLOCATION FACTOR (PUTNAM COUNTY)

TAZ	Area	Allocation Factor 1		Allocation Factor 2			Composite Allocation Factor
		No. of Major Highways	Factor 1	Highway Miles	Hwy Miles per SQM	Factor 2	
3102	27.39	3	4.55%	10.92	0.3987	5.42%	4.98%
3103	3.91	0	0.00%	0.00	0.0000	0.00%	0.00%
3104	12.96	15	22.73%	21.12	1.6301	22.15%	22.44%
3105	7.95	10	15.15%	8.15	1.0254	13.93%	14.54%
3106	11.45	10	15.15%	8.71	0.7604	10.33%	12.74%
3107	9.82	4	6.06%	4.02	0.4089	5.56%	5.81%
3108	8.14	1	1.52%	1.23	0.1514	2.06%	1.79%
3109	2.43	1	1.52%	0.23	0.0945	1.28%	1.40%
3110	7.52	1	1.52%	1.44	0.1917	2.61%	2.06%
3111	5.60	1	1.52%	0.77	0.1384	1.88%	1.70%
3112	4.64	1	1.52%	2.38	0.5125	6.96%	4.24%
3113	13.20	0	0.00%	0.00	0.0000	0.00%	0.00%
3114	27.59	5	7.58%	12.37	0.4484	6.09%	6.83%
3115	13.90	3	4.55%	4.07	0.2927	3.98%	4.26%
3116	32.57	5	7.58%	8.31	0.2550	3.47%	5.52%
3117	1.63	0	0.00%	0.00	0.0000	0.00%	0.00%
3118	2.13	2	3.03%	1.80	0.8431	11.46%	7.24%
3119	2.69	0	0.00%	0.00	0.0000	0.00%	0.00%
3120	36.32	4	6.06%	7.54	0.2076	2.82%	4.44%
TOTAL	231.84	66	100.00%	93.06	7.3588	100.00%	100.00%

3.3.5.6 Highway & Transit Accessibility

Distinct from the proximity to major highways described in Section 3.3.5.5, an attraction measure reflecting highway accessibility in terms of actual travel time was determined. Accessibility to employment opportunities and labor force, retail and service locations, or other destinations is often a factor in the location of firms and residences. Using the BPM's travel time skims the Project Team was able to calculate the highway travel time by single occupancy vehicle (SOV) from one zone to all other zones.

To estimate the average travel time required to access employment from a given zone, the SOV travel time skims were weighted by the volume of journey to work trips from that zone to each other work destination zone. The resulting measure was used to represent the relative zonal attraction from a household and population standpoint. Conversely, to develop a measure representing the zonal attraction from an employment standpoint, the SOV travel times from a given zone were weighted by the volume of all journey to work trips to that zone.

The average travel time measures from both a population and employment standpoint were converted into allocation factors using the logit formulation that is typically applied in choice analysis components

of travel demand models including the BPM. Table 3-11 presents a sample calculation for the highway accessibility allocation factor for Ocean County.

TABLE 3-11. SAMPLE CALCULATION OF HIGHWAY ACCESSIBILITY ALLOCATION FACTOR (OCEAN COUNTY)

TAZ	A	B	C	D
	Avg Travel Time (min)	Disutility (utils)	Disutility Exponent	Allocation Factor
		$B = A \times (-0.045)$	$C = \exp(B)$	$D = C / \Sigma(C)$
4322	39.48	-1.77655	0.16922	2.41%
4323	58.73	-2.64266	0.07117	1.01%
4324	32.93	-1.48206	0.22717	3.23%
4325	41.88	-1.88447	0.15191	2.16%
4326	33.75	-1.51866	0.21900	3.12%
4327	33.75	-1.51866	0.21900	3.12%
4328	27.54	-1.23941	0.28955	4.12%
4329	30.80	-1.38579	0.25013	3.56%
4330	28.80	-1.29584	0.27367	3.89%
4331	30.66	-1.37974	0.25164	3.58%
4332	27.24	-1.22569	0.29356	4.18%
4333	33.94	-1.52723	0.21714	3.09%
4334	44.14	-1.98645	0.13718	1.95%
4335	34.98	-1.57424	0.20717	2.95%
4336	23.45	-1.05513	0.34815	4.95%
4337	37.69	-1.69625	0.18337	2.61%
4338	36.14	-1.62618	0.19668	2.80%
4339	47.25	-2.12614	0.11930	1.70%
4340	36.79	-1.65569	0.19096	2.72%
4341	36.18	-1.62804	0.19631	2.79%
4342	39.48	-1.77655	0.16922	2.41%
4343	36.67	-1.65028	0.19200	2.73%
4344	36.94	-1.66250	0.18966	2.70%
4345	38.58	-1.73622	0.17619	2.51%
4346	28.18	-1.26790	0.28142	4.00%
4347	29.57	-1.33067	0.26430	3.76%
4348	39.36	-1.77110	0.17015	2.42%
4349	38.16	-1.71720	0.17957	2.56%
4350	31.89	-1.43499	0.23812	3.39%
4351	31.24	-1.40586	0.24516	3.49%
4352	30.57	-1.37547	0.25272	3.60%
4353	37.64	-1.69362	0.18385	2.62%
4354	28.84	-1.29759	0.27319	3.89%
TOTAL			7.02782	100.00%

The zonal average travel time is first converted into a measure of travel disutility using travel time disutility coefficients obtained from FTA guidelines on mode choice modeling. To maximize the variability in resulting estimates of zonal attractiveness, each minute of average travel time was penalized at the rate of -0.045 utils per minute. This coefficient value represents the high end of observed responses to travel time sensitivity according the FTA guidance document.

The exponent of each zone's travel time disutility was calculated as shown by column C in Table 3-11. The zonal allocation factor was then calculated by dividing each zones exponentiated disutility, by the total of all exponentiated disutilities in the county.

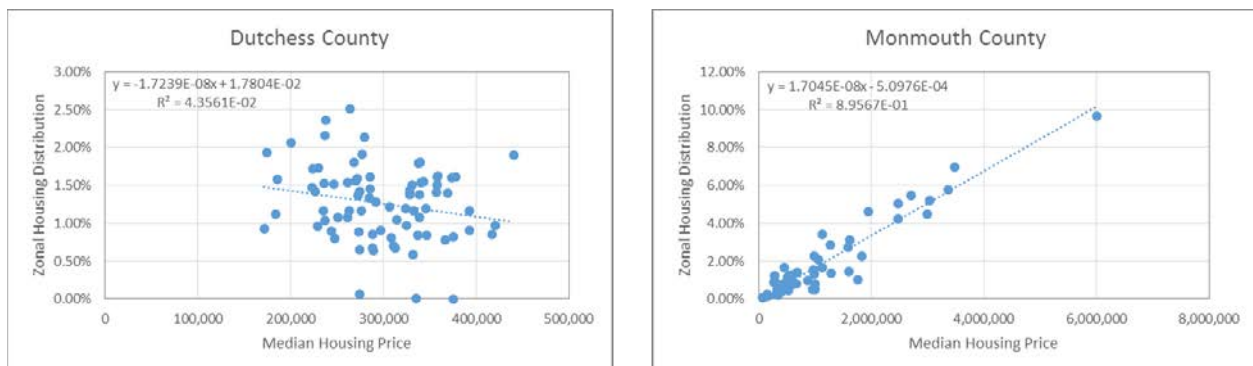
A similar exercise was conducted using travel times by transit to reflect transit accessibility from both a population and employment standpoint. However, in the case of the transit accessibility measures, travel skims from the BPM were used to determine the fastest walkable transit option (commuter rail, subway, bus, or light rail) from each zone. The transit travel times for walk access, transfer waiting times, and other similar out-of-vehicle travel time were doubled so as to reflect the traditional travel time penalties applied to these components of transit travel.

The travel skims obtained from the BPM were run for both 2015 and 2040. Travel skims obtained from both those time frames were therefore deemed to reflect the effects of capacity improvements that have been incorporated into the latest version of the BPM (2014). Zonal travel times for intermediate years between 2015 and 2040 were interpolated before being used to generate allocation factors based on the steps described above. Zonal travel times for 2040 were held constant for both the 2045 and 2050 forecast years.

3.3.5.7 Housing Price

Housing prices were the final dimension of attractiveness considered by the Project Team. Data obtained from U.S. Census was used to determine median housing prices at the zonal level. This information was correlated with observed distribution of housing concentrations at the zonal level to determine the relationship between housing price and the zonal distribution of housing settlements within each county. In some cases, negative correlations were observed implying that housing affordability is a consideration in household locations, while in some cases positive correlations were observed, conversely implying that housing prices acted as a proxy for other desirable factors affecting population settlement (e.g. schools, social amenities, etc.). Figure 3-9 provides two examples of the negative and positive relationship between housing price and zonal housing location distributions.

FIGURE 3-9. SAMPLE CORRELATIONS OF HOUSEHOLD PRICE & ZONAL DISTRIBUTION



Given the individual county variations in both the directionality and strength of relationship between housing price and housing settlement pattern, the Project Team elected to use each county's unique relationship between median housing price and zonal settlement to derive the future zonal attraction measures. Best fit linear equations (similar to those presented in Figure 3-9) were used to directly correlate housing price to zonal preference in percentage terms.

3.3.5.8 Weighting System

The attraction measures described above were combined through a weighting system designed to emphasize those attraction measures that were most relevant to each county. The Project Team conducted a linear regression analysis of relevant factors to estimate the relative importance of each factor on an individual county basis.

Further revisions were made to the resulting weights based on guidance from County Planners and other members of the FWG to ensure a more plausible allocation of households and employment. The final sets of weights applied to the zonal allocation are provided in Tables 3-12 and 3-13 for households and employment respectively.

It should be noted that in the case of employment allocation weights, a factor of zero for the 2000-2010 employment change share was applied to all counties due to the volatility of this variable during the recent Great Recession.

Table 3-14 provides an example of how the various allocation factors are combined to provide a single measure to be incorporated in the actual zonal allocation process later described. By multiplying each of the Putnam household allocation factors in Table 3-14 by the appropriate weights from Table 3-12, and summing the resulting products, a single weighted factor was developed as shown in the last column of Table 3-14.

TABLE 3-12. HOUSEHOLD ALLOCATION FACTOR WEIGHTS

County	2010 Share	2000-2010 Share	Priority Growth Area	Vacant Land	Transit Proximity	Highway Proximity	Transit Accessibility	Highway Accessibility	Housing Price
Nassau	30%	30%	5%	5%	10%	0%	5%	0%	15%
Suffolk	35%	35%	0%	0%	5%	0%	10%	0%	15%
Dutchess	35%	35%	0%	0%	5%	0%	10%	0%	15%
Orange	20%	35%	20%	0%	0%	5%	0%	5%	15%
Putnam	25%	25%	0%	15%	0%	0%	5%	20%	10%
Rockland	25%	25%	0%	5%	5%	0%	15%	0%	25%
Westchester	30%	30%	0%	5%	10%	0%	5%	5%	15%
Bergen	20%	20%	0%	0%	10%	5%	5%	10%	30%
Essex	20%	20%	0%	0%	10%	5%	5%	10%	30%
Hudson	35%	35%	0%	0%	0%	0%	5%	5%	20%
Hunterdon	35%	35%	0%	0%	5%	0%	5%	0%	20%
Mercer	5%	5%	0%	5%	0%	10%	0%	25%	50%
Middlesex	20%	20%	5%	0%	0%	0%	5%	0%	50%
Monmouth	20%	20%	5%	0%	0%	0%	5%	0%	50%
Morris	25%	25%	5%	5%	0%	5%	5%	5%	25%
Ocean	25%	25%	5%	5%	0%	0%	5%	0%	35%
Passaic	10%	10%	5%	0%	10%	0%	5%	0%	60%
Somerset	30%	30%	0%	0%	0%	5%	5%	10%	20%
Sussex	10%	10%	5%	5%	0%	15%	0%	0%	55%
Union	25%	20%	5%	0%	0%	0%	5%	5%	40%
Warren	10%	10%	10%	0%	0%	25%	0%	0%	45%
Fairfield	35%	30%	5%	0%	5%	0%	10%	5%	10%
New Haven	35%	30%	0%	0%	10%	0%	15%	5%	5%

TABLE 3-13. EMPLOYMENT ALLOCATION FACTOR WEIGHTS

County	2010 Share	2002-2010 Share	Priority Growth Area	Vacant Land	Transit Proximity	Highway Proximity	Transt Accessibility	Highway Accessibility
Nassau	30%	0%	25%	5%	20%	5%	10%	5%
Suffolk	20%	0%	20%	5%	10%	25%	20%	0%
Dutchess	25%	0%	0%	0%	15%	45%	15%	0%
Orange	30%	0%	20%	0%	0%	30%	5%	15%
Putnam	25%	0%	0%	0%	25%	25%	25%	0%
Rockland	30%	0%	0%	0%	15%	20%	35%	0%
Westchester	20%	0%	0%	5%	10%	25%	40%	0%
Bergen	25%	0%	0%	25%	25%	15%	10%	0%
Essex	30%	0%	0%	25%	20%	10%	15%	0%
Hudson	35%	0%	0%	35%	15%	5%	5%	5%
Hunterdon	35%	0%	25%	5%	30%	5%	0%	0%
Mercer	30%	0%	0%	55%	0%	10%	5%	0%
Middlesex	35%	0%	35%	5%	20%	0%	5%	0%
Monmouth	35%	0%	10%	10%	25%	5%	5%	10%
Morris	30%	0%	0%	30%	0%	15%	25%	0%
Ocean	25%	0%	0%	25%	10%	5%	35%	0%
Passaic	25%	0%	10%	10%	25%	10%	20%	0%
Somerset	25%	0%	10%	20%	25%	5%	0%	15%
Sussex	25%	0%	5%	25%	0%	10%	30%	5%
Union	30%	0%	0%	30%	25%	15%	0%	0%
Warren	35%	0%	10%	0%	40%	0%	0%	15%
Fairfield	15%	0%	10%	10%	10%	25%	30%	0%
New Haven	30%	0%	15%	5%	20%	15%	15%	0%

TABLE 3-14. WEIGHTED ALLOCATION FACTOR CALCULATION (PUTNAM COUNTY)

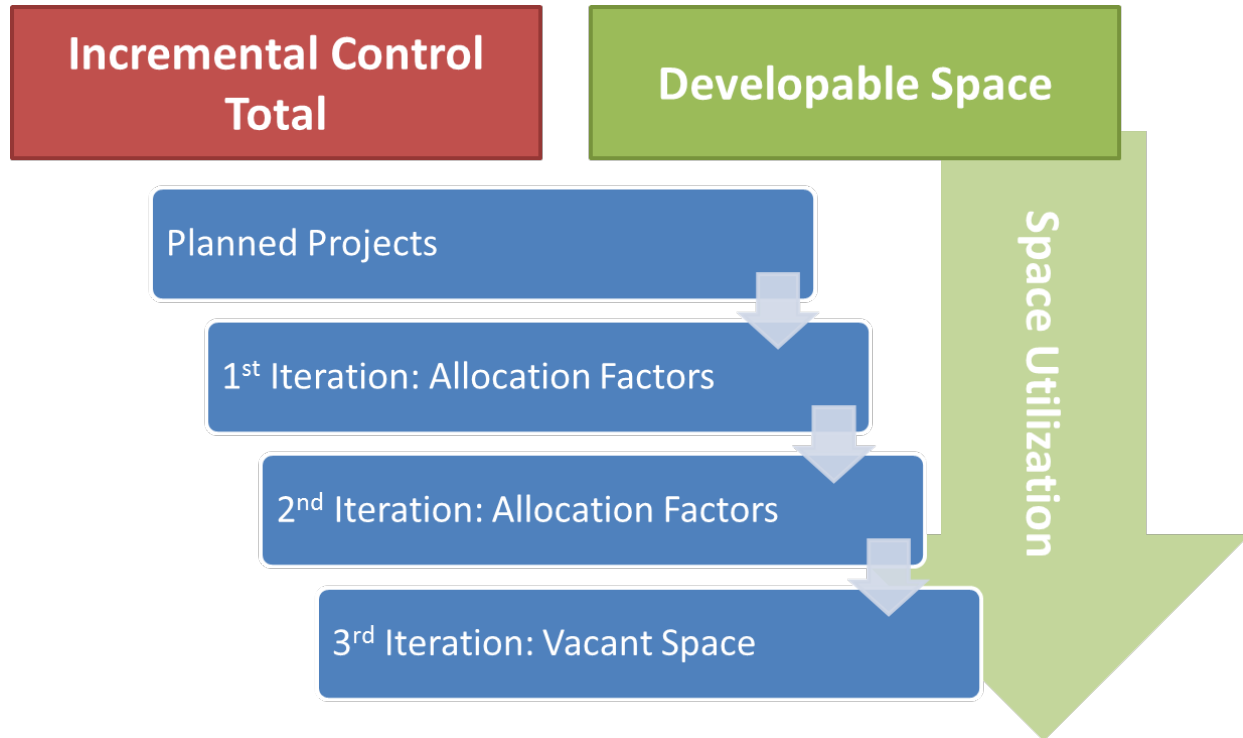
County	Municipality	TAZ	2010 Share	2000-2010 Share	Priority Growth Area	Vacant Land	Transit Proximity	Highway Proximity	Transt Accessibility	Highway Accessibility	Housing Price	WEIGHTED ALLOCATION FACTOR
Putnam	Patterson	3102	7.13%	10.47%	5.26%	17.43%	16.67%	4.98%	0.00%	4.91%	5.36%	8.53%
Putnam	Patterson	3103	4.02%	4.51%	5.26%	2.37%	0.00%	0.00%	0.00%	4.91%	5.61%	4.03%
Putnam	Southeast	3104	5.35%	5.09%	5.26%	8.47%	0.00%	22.44%	0.00%	5.20%	5.09%	5.43%
Putnam	Southeast	3105	8.31%	5.34%	5.26%	4.56%	33.33%	14.54%	4.12%	5.91%	5.43%	6.03%
Putnam	Southeast	3106	5.39%	8.21%	5.26%	3.34%	0.00%	12.74%	0.00%	5.61%	5.33%	5.56%
Putnam	Carmel	3107	6.66%	18.46%	5.26%	3.48%	0.00%	5.81%	13.84%	5.34%	5.17%	9.08%
Putnam	Carmel	3108	5.70%	6.54%	5.26%	2.34%	0.00%	1.79%	0.00%	5.27%	5.09%	4.97%
Putnam	Carmel	3109	4.03%	0.73%	5.26%	1.01%	0.00%	1.40%	0.00%	5.27%	5.19%	2.91%
Putnam	Carmel	3110	5.41%	8.54%	5.26%	3.64%	0.00%	2.06%	0.00%	5.10%	5.06%	5.56%
Putnam	Carmel	3111	4.73%	2.87%	5.26%	2.04%	0.00%	1.70%	0.00%	5.10%	5.29%	3.75%
Putnam	Carmel	3112	6.78%	3.05%	5.26%	2.11%	0.00%	4.24%	0.39%	5.89%	5.28%	4.50%
Putnam	Putnam Vall	3113	8.00%	4.94%	5.26%	6.27%	0.00%	0.00%	0.00%	5.53%	5.35%	5.82%
Putnam	Putnam Vall	3114	4.03%	2.33%	5.26%	10.75%	0.00%	6.83%	0.00%	5.48%	5.21%	4.82%
Putnam	Philipstown	3115	3.41%	3.31%	5.26%	4.39%	33.33%	4.26%	0.00%	5.15%	5.06%	3.87%
Putnam	Philipstown	3116	3.82%	7.19%	5.26%	10.18%	0.00%	5.52%	0.45%	5.13%	4.74%	5.80%
Putnam	Philipstown	3117	3.28%	2.40%	5.26%	0.01%	16.67%	0.00%	0.45%	5.13%	5.29%	3.00%
Putnam	Kent	3118	5.12%	0.00%	5.26%	1.12%	0.00%	7.24%	40.38%	5.28%	5.68%	5.09%
Putnam	Kent	3119	3.55%	1.71%	5.26%	1.37%	0.00%	0.00%	40.38%	5.28%	5.52%	5.15%
Putnam	Kent	3120	5.28%	4.32%	5.26%	15.11%	0.00%	4.44%	0.00%	4.53%	5.26%	6.10%
TOTAL			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

3.3.6 ZAP Model Growth Fitting

Starting with the base year zonal allocation of all household and total employment variables, the Project Team allocated future incremental growth of both categories of variables with due consideration of developable area constraints, anticipated location and scale of planned projects, and allocation factors

representing the desirability of each zone. Figure 3-10 provides a high-level overview of the zonal allocation processes for households and employment as they are executed within the Zonal Allocation Model developed by the Project Team.

FIGURE 3-10. ZONAL ALLOCATION PROCESS OVERVIEW



The fitting of incremental households and employment in the allocation process is conducted through four allocation steps that consume developable space through each successive round. The rate at which developable space is consumed is determined by each zone's place typology as described in Section 3.3.3.2.1. Existing rates of development density (expressed as housing units per acre of jobs per acre) were calculated from the base year allocation. Future rates of development density were then derived based on the assumptions of future increases in density of development as outlined in Table 3-5. The resulting rates of future development density per acre are provided in Table 3-15.

Planned Projects. As shown in Figure 3-10, the incremental addition of employment and households in each forecast interval was first performed on the basis of the distributions implied by planned projects. This approach is similar to that applied in the 2040 SED allocation and is believed to represent a reliable market and governmental policy view of likely growth areas, particularly in the near term forecast.

Developable space is consumed during the allocation of planned projects based on the allowable densities provided in Table 3-15. The residual developable area following the allocation conducted through planned projects was carried forward to the first growth fitting iteration displayed in Figure 3-10. In the event that the implied developable space required to accommodate the planned projects in a given zone exceeded the estimated vacant developable area, the planned project was assumed to proceed with no modification to its anticipated scale as it was assumed that local knowledge of capacity constraints were prioritized over the

estimations calculated using parcel data and redevelopment potential assumptions discussed in Section 3.3.3.

1st and 2nd Iterations with Allocation Factors. The remaining incremental control total of employment or households to be allocated after accounting for the absorption by planned projects was subsequently allocated using the allocation factors described in Section 3.3.5. Subject to the availability of land in each zone, the weighted allocation factor (such as that described in Table 3-14) was used to allocate employment or housing up to the carrying capacity limited implied by dividing each zone's vacant developable area by the corresponding future density of development assumptions. Incremental employment and housing control totals that were not allocated during the first iteration were allocated in a second iteration based on the allocation factors.

TABLE 3-15. FUTURE DEVELOPMENT DENSITY ASSUMPTIONS BY PLACE TYPOLOGY

County	Future Employment/Acre by Place Typology									Future Housing Units/Acre by Place Typology								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
Nassau	93.2	52.3	38.9	38.6	25.0	19.9	9.0	2.3	1.4	33.3	22.4	29.0	8.7	9.0	5.1	6.0	1.6	0.5
Suffolk	112.0	42.7	29.1	26.6	18.4	16.0	9.1	6.3	2.2	23.0	19.6	20.0	7.4	7.7	4.1	4.2	1.9	1.4
Dutchess	76.9	54.8	51.3	45.7	30.7	13.5	6.1	3.4	1.3	28.0	24.2	24.7	10.5	10.9	4.9	5.4	1.6	0.3
Orange	75.6	51.2	38.1	31.3	21.7	13.6	8.5	6.4	1.6	32.5	28.1	28.6	14.2	18.6	6.1	5.8	2.1	0.5
Putnam	75.5	53.8	50.4	44.9	30.1	13.2	6.0	3.3	1.3	14.4	12.4	12.2	8.3	9.3	2.8	3.2	1.6	0.6
Rockland	87.6	48.3	40.6	31.0	26.4	11.8	8.0	6.5	1.5	19.8	17.1	16.8	11.5	12.7	3.8	4.4	1.7	1.0
Westchester	119.9	64.3	52.5	44.2	35.8	17.6	12.1	8.3	3.9	42.1	37.1	40.1	13.6	15.4	4.5	5.3	1.3	0.5
Bergen	122.3	82.6	65.5	51.2	39.0	23.3	19.0	10.8	3.2	35.5	28.8	29.3	9.0	10.1	3.1	3.3	1.3	0.6
Essex	143.7	67.9	46.8	43.8	28.8	18.2	14.1	24.6	8.7	37.4	30.4	30.9	9.5	10.7	3.3	3.4	1.3	0.7
Hudson	208.9	98.6	86.1	30.5	20.6	8.0	4.2	4.7	8.7	91.8	74.5	75.9	23.4	26.1	8.0	8.4	3.3	1.6
Hunterdon	129.7	52.9	51.2	37.8	26.1	15.6	12.7	7.2	2.1	16.3	13.2	13.4	4.1	4.6	1.4	1.5	0.6	0.3
Mercer	129.7	52.9	51.2	37.8	26.1	15.6	12.7	8.1	2.5	19.4	17.1	17.4	5.4	6.0	1.8	1.9	0.8	0.4
Middlesex	129.7	52.9	51.2	37.8	26.1	15.6	12.7	8.1	2.1	19.4	15.7	16.0	5.4	6.0	1.8	1.9	0.8	0.3
Monmouth	129.7	52.9	51.2	37.8	26.1	15.6	12.7	7.2	2.1	16.3	13.2	13.4	4.1	4.6	1.4	1.5	0.6	0.3
Morris	129.7	52.9	51.2	37.8	26.1	15.6	12.7	7.2	2.1	16.3	13.2	13.4	4.1	4.6	1.4	1.5	0.6	0.3
Ocean	135.1	55.1	53.4	42.4	29.2	17.5	14.2	9.1	2.8	16.3	13.2	13.4	4.8	5.4	1.6	1.7	0.7	0.4
Passaic	135.1	55.1	53.4	39.3	27.2	16.2	13.2	7.5	2.2	35.5	28.8	29.3	9.0	10.1	3.1	3.3	1.3	0.6
Somerset	129.7	52.9	51.2	37.8	26.1	15.6	12.7	7.2	2.1	16.3	13.2	13.4	4.1	4.6	1.4	1.5	0.6	0.3
Sussex	125.2	41.1	64.0	32.7	32.3	31.1	24.0	3.1	8.7	16.3	13.2	13.4	4.1	4.6	1.4	1.5	0.6	0.3
Union	125.2	41.1	64.0	32.7	32.3	31.1	24.0	3.1	8.7	24.1	19.6	19.9	6.7	7.4	2.3	2.4	0.9	0.4
Warren	84.5	39.9	36.2	19.6	11.6	10.9	6.3	4.3	1.8	16.3	13.2	13.4	4.1	4.6	1.4	1.5	0.6	0.3
Fairfield	84.5	39.9	36.2	19.6	11.6	10.9	6.3	4.9	1.8	42.0	33.8	37.5	13.0	19.3	3.5	4.9	1.2	0.4
New Haven	119.8	56.6	51.3	27.8	16.4	15.5	9.0	7.0	2.6	27.9	32.1	38.8	12.1	20.7	3.2	5.9	1.4	0.5

3rd Iteration with Vacant Space. Any residuals still unallocated due to land use capacity constraints during the 1st and 2nd iterations described above, were then allocated in accordance to the amount of vacant space available within the county. It should be noted that the volume of households and employment allocated during this last phase was zero in the majority of counties and only represented a very small fraction of the total future year allocations.

Given the potential land capacity constraints, the incremental addition of future year employment preceded the incremental addition of households in each five year interval, so as to ensure that employment received priority as vacant land was consumed with each preceding round of incremental allocations. This approach was designed to minimize the amount of employment that was allocated to vacant space (likely in more rural areas) in the third iteration of growth fitting described above.

This process was repeated for each five year interval within the 2015-2050 forecast horizon. With the exception of a handful of counties, the total employment and households were fitted into corresponding TAZs without exceeding land use capacity assumptions as described above.

More aggressive future density assumptions had to be applied to fit growth in Ocean County, while Mercer, Middlesex, Union, Fairfield and New Haven Counties all needed smaller adjustments in their future density assumptions.

3.3.7 Allocation of Employment Variables

As indicated previously, the employment growth fitting exercise described above, allocated total employment in terms of jobs to each county's TAZs – subject to the availability of developable space. Once this phase was completed, the allocation of commuting workers was conducted, starting with the base year allocation, and incrementally adjusting each zone's total, retail, and office employment in a manner that mirrored the pattern of zonal job growth obtained from the growth fitting exercise.

In the case where the incremental change from one 5-year interval to the next was negative, employment was reduced in proportion to the distribution of employment at the beginning of that interval.

3.3.8 Allocation of Households and Population Variables

Households. The growth fitting exercise described above used households as the basis of zonal allocation and the zonal volumes allocated were simply added in incremental fashion to the base year zonal allocation.

Household Population. The incremental household population to each zone was calculated by multiplying the number of allocated households by the corresponding average household size estimate for each forecast year interval. However, before adding this zonal estimate of household population, a minor adjustment to the initial household population was necessary to maintain consistency with the county level forecasts of households.

The change in households as forecasted by the county level projections are a reflection of both population growth in numerical terms, and population change in terms of shifting age profiles and resulting alterations to household formation rates. So a minor adjustment to each zone's initial household population estimate was also required to ensure consistency with the control totals from the county level forecast.

Group Quarters Population. Starting with the base year zonal allocation of group quarter (GQ) population by the various types listed in Table 1-1, GQ populations were proportionally scaled in place to match the growth implied in the GQ county level control total.

Total Population. The zonal total population was simply calculated by summing up populations in households and group quarters.

Average Household Size. The zonal average household size estimates were calculated by simply dividing household population by number of households.

Employed Civilian Labor Force. The zonal employed civilian labor force was calculated by multiplying the zonal estimate of total population, by the appropriate ratio of the county-level employment forecast divided by the county level forecast of employed labor force.

3.3.9 K-12 School Enrollment

3.3.9.1 K-12 School Enrollment Base Year Allocation

School enrollment data was collected from the New York State Education Department, the New Jersey Department of Education and the Connecticut State Department of Education. While both public and private enrollment data was available on the websites for New York and Connecticut, New Jersey does not make private school enrollment publicly available online. Private school enrollment, therefore, was obtained from a representative of the Office of Nonpublic School Services at the New Jersey Department of Education. At the time of analysis, each state had varying years of data available and a determination was made to use the most recent, fully available dataset as the base year (2012) value. The following school years were used for each state:

- New York: 2013-2014
- Connecticut: 2010-2011
- New Jersey: 2013-2014 (Public); 2014-2015 (Private)

Each school was geocoded and assigned a TAZ. The results were aggregated by county to arrive at base year estimates by county.

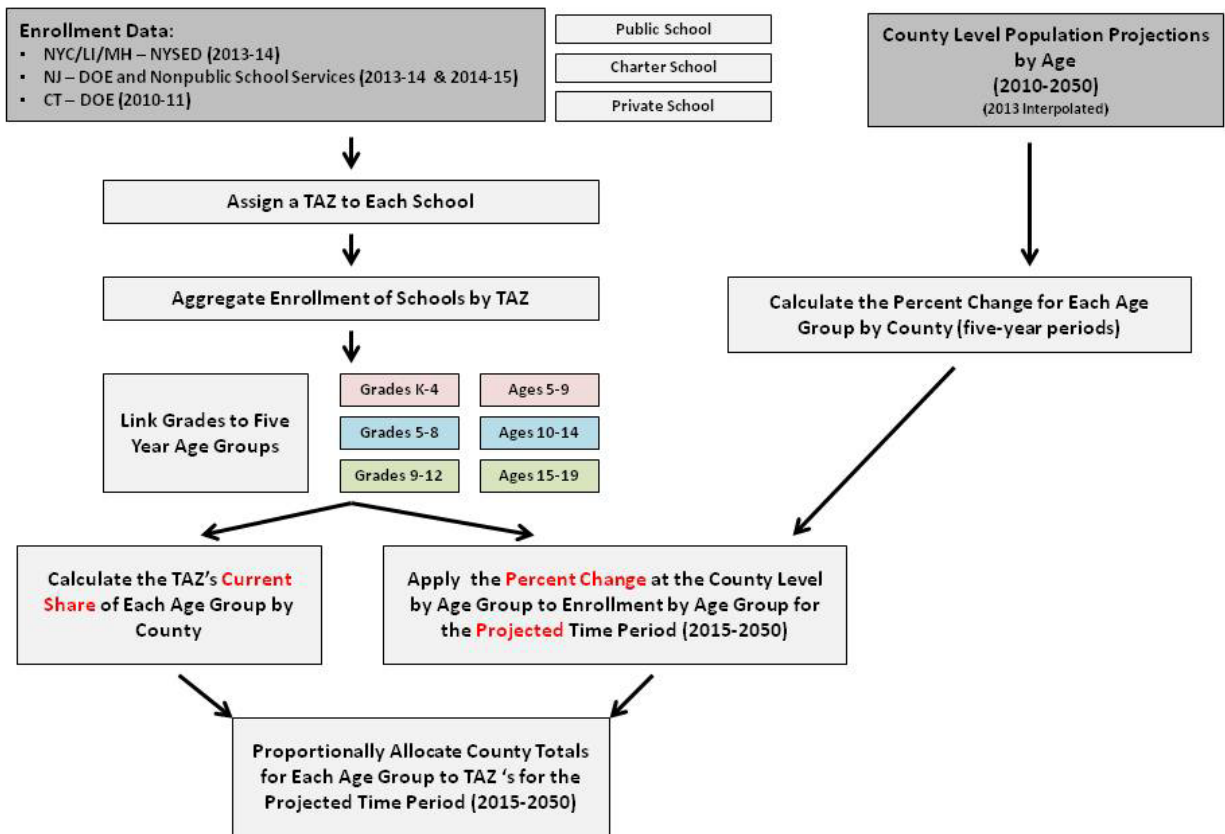
3.3.9.2 K-12 School Enrollment Future Year Allocations

School enrollment by grade was linked to five-year age groups, using the following age-grade equivalency:

- Grades K-4: Ages 5-9
- Grades 5-8: Ages 10-14
- Grades 9-12: Ages 15-19

Reported enrollments by school were aggregated for each county for the base year and then projected forward using changes in the population of selected age/sex groups from county population projections. For example, the growth rate in Nassau County between 2025 and 2030 for 5-9 year olds is projected to be 6.3%. Therefore, the county control for Nassau for K-4 (represented by 5-9 year olds) in 2025 grows by 6.3% and that new control for 2030 is distributed to the TAZs in the same proportion as was established in the base year. Figure 3-11 describes the process.

FIGURE 3-11. K-12 ENROLLMENT BY TAZ



Enrollment for K-12 (Table 3-16) is projected to increase most substantially in the Mid-Hudson region, growing 23% between 2012 and 2050, followed by a projected 13% increase in New Jersey. Long Island is anticipated to have a more modest increase. Growth in these regions is driven by Orange, Hudson and Ocean counties, which experience growth rates of over 25% between 2012 and 2050. Of note is the initial dip in school enrollment across the region, which extends through 2025, before maintaining positive growth through the 2050 forecast horizon. The trend of decreasing births and an aging population drives this initial decline, which stabilizes as newer age cohorts progress through the model.

TABLE 3-16. HISTORIC AND PROJECTED SCHOOL ENROLLMENT

	2012-2050										
	2012	2015	2020	2025	2030	2035	2040	2045	2050	Difference	CAGR
Nassau County	230,473	226,615	216,662	216,959	225,289	241,406	255,776	265,632	270,446	39,973	17.3%
Suffolk County	258,666	241,744	229,023	226,392	234,892	247,079	254,393	257,217	257,004	(1,662)	-0.6%
Long Island Total	489,139	468,359	445,685	443,351	460,181	488,485	510,169	522,849	527,449	38,310	7.8%
Dutchess County	46,049	42,888	40,586	40,651	42,908	45,749	47,651	48,227	48,197	2,148	4.7%
Orange County	74,549	74,687	74,612	77,246	82,110	88,341	94,132	98,852	103,317	28,768	38.6%
Putnam County	15,598	14,220	13,107	12,624	13,213	14,097	14,950	15,403	15,422	(176)	-1.1%
Rockland County	64,961	67,659	68,475	69,891	72,361	76,007	80,020	83,237	86,397	21,436	33.0%
Westchester Coun	169,736	168,540	164,273	160,743	166,376	176,848	188,718	198,249	204,451	34,715	20.5%
Mid-Hudson Total	370,893	367,995	361,054	361,156	376,968	401,042	425,472	443,968	457,783	86,890	23.4%
Bergen County	153,981	155,424	148,990	145,798	148,331	157,874	166,738	172,608	174,309	20,328	13.2%
Essex County	137,002	137,139	134,059	133,222	133,779	138,655	144,751	149,324	153,992	16,991	12.4%
Hudson County	89,384	96,251	97,369	101,421	104,226	106,727	108,245	109,685	112,688	23,304	26.1%
Hunterdon County	21,281	19,545	17,555	16,056	16,017	17,158	18,479	19,386	19,418	(1,863)	-8.8%
Mercer County	63,286	62,030	61,723	63,081	66,218	70,517	74,399	77,234	79,389	16,103	25.4%
Middlesex County	134,111	133,556	131,118	130,716	133,753	139,622	145,000	148,955	152,359	18,248	13.6%
Monmouth County	110,416	103,200	96,049	92,492	92,808	97,749	101,193	102,850	102,407	(8,010)	-7.3%
Morris County	84,237	81,144	76,841	73,013	73,050	76,382	80,122	82,154	81,319	(2,918)	-3.5%
Ocean County	96,941	99,995	103,652	108,124	111,251	117,954	122,454	128,554	135,142	38,201	39.4%
Passaic County	89,417	86,468	84,882	85,599	89,243	93,322	99,043	102,284	104,794	15,377	17.2%
Somerset County	62,286	60,588	56,391	52,894	52,663	56,578	60,020	61,798	61,464	(822)	-1.3%
Sussex County	24,468	22,005	20,403	19,573	19,825	20,772	21,484	21,540	21,102	(3,366)	-13.8%
Union County	95,947	97,830	96,284	97,171	99,329	105,011	111,045	115,218	118,804	22,857	23.8%
Warren County	17,699	16,655	15,272	14,313	14,192	14,866	15,554	15,674	15,352	(2,347)	-13.3%
New Jersey Total	1,180,455	1,171,830	1,140,586	1,133,473	1,154,685	1,213,188	1,268,527	1,307,264	1,332,538	152,083	12.9%
Fairfield County	162,674	162,846	154,692	152,661	156,055	166,948	176,914	183,715	187,561	24,887	15.3%
New Haven County	138,351	132,737	126,616	126,674	131,393	138,851	143,939	145,521	145,559	7,208	5.2%
Connecticut Total	301,025	295,583	281,309	279,335	287,448	305,799	320,853	329,236	333,120	32,095	10.7%

Source: New York, New Jersey and Connecticut State Departments of Education

3.3.10 University Enrollments

3.3.10.1 University Enrollment Base Year Allocation

University enrollment was available from The New York State Education Department for New York, the Connecticut Office of Higher Education and the New Jersey Office of Higher Education. As with school enrollment, each state had varying years of information available at the time of analysis and determination was made to use the most recent, fully available dataset as the base year value. Enrollment was considered the sum of undergraduate and graduate students both full and part-time. The following school years were used for each state:

- New York: Fall 2013
- Connecticut: Fall 2011
- New Jersey: Fall 2014

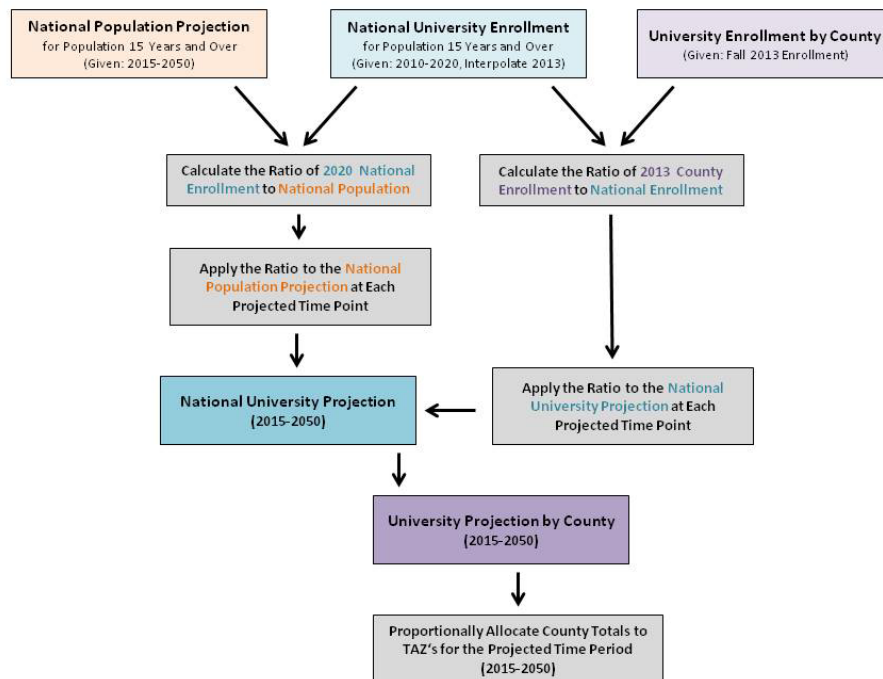
The address of each college and university was verified via Google Maps to ensure the location correctly matched the TAZ corresponding to the main campus. Oftentimes, the geocoded address was for mailing purposes and not relevant for travel demand analysis. To arrive at base year estimates, the enrollment was aggregated to the TAZ level and then up to the county level.

3.3.10.2 University Enrollment Future Year Allocations

Consistent with the methodology employed for New York City, it was determined that since the population eligible for university enrollment goes well beyond the boundaries of the region, national trends were used to project university enrollment. Data was used from the National Center for Education Statistics (NCES), which releases projected national university enrollment to 2021, as well as the U.S. Census Bureau's national projections by age to 2060.²⁴ The share of the national population that is projected to be enrolled at the university level has increased since 2010, but at a slower rate, compared with the prior decade, 2000-2010. To estimate future growth, a quarter of the difference between the shares of the population ages 15+ that were enrolled in 2000 and in 2020 was taken, and added to each decade post-2020, which was then used to derive the projected national population enrolled in universities. An eighth was used to account for varying growth rates between periods and to better align the 20 year difference with 5 year time increments moving forward.

For the base year, national university enrollment data were used to establish the ratio of county enrollment relative to that for the nation (shown on the far right, in the bottom half of Figure 3-13 below). This ratio was then applied to the projected enrollment for the nation to derive enrollment by county at each projected time point. The future county level totals were then proportionally allocated to the TAZs in the same proportion as established by the base year estimates.

FIGURE 3-12. UNIVERSITY ENROLLMENT BY TAZ – OVERVIEW



²⁴ See <http://nces.ed.gov/programs/projections/projections2021/> and <http://www.census.gov/population/projections/data/national/2014/summarytables.html>

FIGURE 3-13. UNIVERSITY ENROLLMENT BY TAZ – CALCULATIONS

NATIONAL CENSUS PROJECTIONS										
Population 15+	2000		Census Population Projection							
	2000	2010	2015	2020	2025	2030	2035	2040	2045	2050
Population 15+	221,168,531	247,518,325	260,351,000	272,928,000	284,881,000	295,695,000	305,889,000	315,276,000	323,824,000	331,853,000
NATIONAL UNIVERSITY ENROLLMENT										
Population 15+	NCES		Interpolated		NCES Projected		National University Enrollment as a Percentage of National Population Projections ^A			
	2000	2010	2012	2015	2020	2025	2030	2035	2040	2050
Population 15+	15,312,289	21,016,123	21,510,603	22,252,324	23,866,783	25,560,628	27,204,110	28,838,382	30,441,151	32,003,744
Ratio National Enrollment to to Population 15+	6.92%	8.49%		8.55%	8.74%	8.97%	9.20%	9.43%	9.66%	9.88%
										10.11%
^A Growth rate determined by adding one-eighth of the difference between 2020 and 2000 ratios to each forecast year beyond 2020										
University Enrollment by County	Base Year		County Enrollment Projection as a Percentage of National University Enrollment Projection							Ratio of Base Year County Enrollment to National*
	2012	2015	2020	2025	2030	2035	2040	2045	2050	
Nassau County	72,893	74,550	79,958	85,633	91,139	96,614	101,984	107,219	112,408	0.34%
Suffolk County	63,705	65,153	69,880	74,839	79,651	84,436	89,129	93,704	98,240	0.29%
Long Island Total	136,598	139,702	149,838	160,472	170,790	181,050	191,113	200,923	210,648	
Dutchess County	24,622	25,182	27,009	28,925	30,785	32,635	34,448	36,217	37,970	0.11%
Orange County	9,715	9,936	10,657	11,413	12,147	12,877	13,592	14,290	14,982	0.04%
Putnam County										0.00%
Rockland County	14,970	15,310	16,421	17,586	18,717	19,842	20,944	22,019	23,085	0.07%
Westchester County	47,362	48,438	51,953	55,640	59,217	62,775	66,264	69,665	73,037	0.22%
Mid-Hudson Total	96,669	98,866	106,039	113,565	120,866	128,127	135,248	142,191	149,073	
Bergen County	34,605	36,214	38,842	41,599	44,273	46,933	49,541	52,084	54,605	0.16%
Essex County	37,097	38,822	41,639	44,594	47,461	50,313	53,109	55,835	58,538	0.17%
Hudson County	27,290	28,559	30,631	32,805	34,915	37,012	39,069	41,075	43,063	0.13%
Hunterdon County										0.00%
Mercer County	51,599	53,999	57,917	62,027	66,015	69,981	73,870	77,662	81,421	0.24%
Middlesex County	73,525	76,945	82,527	88,384	94,067	99,718	105,260	110,663	116,020	0.35%
Monmouth County	21,579	22,583	24,221	25,940	27,608	29,266	30,893	32,479	34,051	0.10%
Morris County	16,407	17,170	18,416	19,723	20,991	22,252	23,489	24,694	25,890	0.08%
Ocean County	19,530	20,438	21,921	23,477	24,986	26,488	27,960	29,395	30,818	0.09%
Passaic County	40,028	41,890	44,929	48,118	51,211	54,288	57,305	60,247	63,163	0.19%
Somerset County	8,646	9,048	9,705	10,393	11,062	11,726	12,378	13,013	13,643	0.04%
Sussex County	3,794	3,970	4,259	4,561	4,854	5,146	5,432	5,710	5,987	0.02%
Union County	28,658	29,991	32,167	34,450	36,665	38,867	41,027	43,134	45,221	0.13%
Warren County	4,830	5,055	5,421	5,806	6,179	6,551	6,915	7,270	7,622	0.02%
New Jersey Total	367,588	384,685	412,594	441,876	470,288	498,540	526,248	553,261	580,040	
Fairfield County	38,883	39,320	42,172	45,165	48,069	50,957	53,789	56,550	59,288	0.18%
New Haven County	73,299	74,123	79,501	85,143	90,618	96,061	101,400	106,605	111,765	0.33%
Connecticut Total	112,182	113,443	121,673	130,309	138,687	147,019	155,190	163,156	171,053	
*Calculation varies by region: New York: Base year enrollment divided by 2013 national university enrollment New Jersey: Base year enrollment divided by 2011 national university enrollment Connecticut: Base year enrollment divided by 2014 national university enrollment Sources: National Population Projections: http://www.census.gov/population/projections/data/national/2014/summarytables.html National University Projections: http://nces.ed.gov/programs/projections/projections2021/ New York university enrollment: http://eservices.nysed.gov/orise/r_creditsenrollment.jsp New Jersey university enrollment: New Jersey Office of Higher Education Connecticut university enrollment: Connecticut Office of Higher Education										

As growth rates in the counties were determined by national population projections and the ensuing share of national university enrollment, the rates are uniform by sub-region. The largest nominal growth is projected in the following counties with the larger universities listed in parentheses: Middlesex (Rutgers University), Nassau (Hofstra University, Long Island University – C.W. Post Campus and Nassau Community College), Suffolk (SUNY at Stonybrook and Suffolk County Community College) and New Haven (Yale University and Southern Connecticut State University) counties.

3.3.11 Average Household Income

The data source for household income was the 2008-2012 American Community Survey 5-Year Estimates. Average household income was calculated by dividing the aggregate household income by the total number of households in each TAZ. The aggregate household income data was collected at the census tract level and converted to TAZs using a TAZ to tract lookup table. Where a tract crosses the boundary of multiple TAZs, census blocks were used to determine how the tract should be split among TAZs. For the average household income variable, the split by number of households was used to make this determination. Since the data were calculated in 2012 dollars, an adjustment factor was applied to the results, to produce average household income in 2010 dollars by TAZ. Average household income was held constant for the entire forecast period (2010-2050).

3.3.12 Median Earnings per Worker

Median earnings per worker were calculated using workplace data from the 2006-2010 CTPP. Data is provided at the census tract level and converted to TAZs using a TAZ to tract lookup table. Where a tract crosses the boundary of multiple TAZs, census blocks were used to determine how the tract should be split among TAZs. For the earnings per worker variable, the split by number of jobs was used to make this determination. Earnings data is available by downloading tables indicating the number of workers in each tract whose earnings fall into a given range:

- \$1 to \$9,999 or less
- \$10,000 to \$14,999
- \$15,000 to \$24,999
- \$25,000 to \$34,999
- \$35,000 to \$49,999
- \$50,000 to \$64,999
- \$65,000 to \$74,999
- \$75,000 to \$99,999
- \$100,000 or more
- No earnings in the past 12 months

After the tract-level data was converted to TAZ-level data, the share of each earnings bracket by TAZ was calculated and a cumulative distribution established. Using the cumulative distribution, the median earnings were calculated by interpolating the value between the end points of the earnings brackets where the 50th percentile lay. For example, if the 50th percentile was between the \$25,000 to \$34,999 and \$35,000 to \$49,999 brackets, the end points (\$35,000 and \$50,000) would be used along with the cumulative percentages that correspond to the brackets to arrive at the interpolated value between \$35,000 and \$50,000. The median earnings per workers were held constant for the entire forecast period (2010-2050).