



PRINCE WILLIAM
COUNTY

Reimagining Population Estimates in Prince William

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Basis for New Estimate Methods

- 2020 population underestimated by ~10,000
- Potential reasons:
 - Applying county-wide average household sizes and occupancy rates by housing type to all housing units
 - Relying 100% on census data
 - US Census has different definition of a housing unit when collecting data for decennial census
 - Underestimating the intensity of housing market and cost of living pressures on families and individuals in the metro area

Basis for New Estimate Methods

- Old methods rely on census blocks
- What we know about 2020 census block data:

Housing Units:			
2020 Census - PWC	Block		
Housing Unit Database	Count	%	
<= -100	5	0.12%	
-25- -99	7	0.17%	
-10- -24	24	0.58%	
-5- -9	33	0.80%	
-1- -4	335	8.13%	
0	3,237	78.59%	
1-4	368	8.93%	
5-9	47	1.14%	
10-24	35	0.85%	
25-99	20	0.49%	
>=100	8	0.19%	
	4,119		

- NVRC demonstrated large variability at units smaller than census tract
- While housing units and vacancy are invariant, total population is not
- Thus, average household size is subject to differential privacy

Average Household Size in the Region

	2000	2010	2020
US	2.59	2.58	2.55
MD	2.61	2.61	2.61
VA	2.54	2.54	2.53

	2000	2010	2020	2000-2010 Change	2010-2020 Change	2000-2020 Change	Conseq >	Conseq <
JURISDICTION	2.14	2.09	2.09	-0.05	0.00	-0.05		
District of Columbia	2.16	2.11	2.08	-0.05	-0.03	-0.08		Y
Arlington County	2.15	2.09	2.14	-0.06	0.05	-0.01		
City of Alexandria	2.04	2.03	2.09	-0.01	0.06	0.05		
Central Jurisdictions	2.71	2.73	2.74	0.02	0.01	0.04	Y	
Montgomery County	2.66	2.70	2.72	0.04	0.02	0.06	Y	
City of Rockville	2.65	2.54	2.49	-0.11	-0.05	-0.16		Y
City of Gaithersburg	2.65	2.70	2.67	0.05	-0.03	0.02		
Prince George's County	2.74	2.78	2.77	0.04	-0.01	0.03		
Fairfax County	2.74	2.74	2.77	0.00	0.03	0.03		
City of Fairfax	2.61	2.64	2.71	0.03	0.07	0.10	Y	
City of Falls Church	2.31	2.41	2.49	0.10	0.08	0.18	Y	
Inner Suburbs	2.82	2.90	2.94	0.08	0.04	0.12	Y	
Loudoun County	2.82	2.98	3.05	0.16	0.07	0.23	Y	
Prince William County	2.94	3.05	3.12	0.11	0.07	0.18	Y	
City of Manassas	2.92	3.02	3.05	0.10	0.03	0.13	Y	
City of Manassas Park	3.16	3.17	3.20	0.01	0.03	0.04	Y	
Charles County	2.86	2.83	2.79	-0.03	-0.04	-0.07		Y
Frederick County	2.72	2.70	2.71	-0.02	0.01	-0.01		
City of Frederick	2.42	2.50	2.54	0.08	0.04	0.12	Y	
Outer Suburbs	2.69	2.67	2.68	-0.02	0.01	-0.01		
Anne Arundel County	2.65	2.63	2.63	-0.02	0.00	-0.02		
Carroll County	2.81	2.74	2.68	-0.07	-0.06	-0.13		Y
Howard County	2.71	2.72	2.77	0.01	0.05	0.06	Y	

Occupancy Rates in the Region

	2000	2010	2020
US	91.0%	88.6%	90.3%
MD	92.3%	90.7%	91.7%
VA	92.9%	90.8%	91.8%

	2000	2010	2000-2010	2010-2020	2000-2020	Conseq >	Conseq <
JURISDICTION	92.3%	91.2%	90.5%	-0.01	-0.01	-0.02	Y
District of Columbia	90.4%	89.9%	89.2%	0.00	-0.01	-0.01	Y
Arlington County	95.5%	93.0%	92.3%	-0.02	-0.01	-0.03	Y
City of Alexandria	96.3%	94.1%	93.9%	-0.02	0.00	-0.02	Y
Central Jurisdictions	96.5%	94.6%	95.7%	-0.02	0.01	-0.01	
Montgomery County	97.0%	95.0%	95.7%	-0.02	0.01	-0.01	
City of Rockville	97.0%	94.0%	95.2%	-0.03	0.01	-0.02	
City of Gaithersburg	94.9%	94.3%	95.3%	-0.01	0.01	0.00	
Prince George's County	94.8%	92.6%	95.1%	-0.02	0.02	0.00	
Fairfax County	97.6%	96.0%	96.2%	-0.02	0.00	-0.01	
City of Fairfax	97.9%	96.2%	94.3%	-0.02	-0.02	-0.04	Y
City of Falls Church	94.6%	92.9%	94.2%	-0.02	0.01	0.00	
Inner Suburbs	96.0%	94.6%	96.1%	-0.01	0.02	0.00	
Loudoun County	96.4%	95.6%	96.7%	-0.01	0.01	0.00	
Prince William County	96.4%	95.4%	97.0%	-0.01	0.02	0.01	
City of Manassas	97.1%	95.5%	97.3%	-0.02	0.02	0.00	
City of Manassas Park	96.7%	91.9%	97.4%	-0.05	0.05	0.01	
Charles County	94.9%	93.2%	95.1%	-0.02	0.02	0.00	
Frederick County	96.0%	94.1%	95.0%	-0.02	0.01	-0.01	
City of Frederick	94.5%	92.0%	94.2%	-0.03	0.02	0.00	
Outer Suburbs	96.2%	94.7%	95.2%	-0.01	0.00	-0.01	
Anne Arundel County	95.6%	93.8%	94.4%	-0.02	0.01	-0.01	
Carroll County	96.8%	95.8%	95.8%	-0.01	0.00	-0.01	
Howard County	97.0%	95.9%	96.4%	-0.01	0.01	-0.01	

Old Methods

- Identify census blocks with 100% single-family detached, single-family attached, or multifamily units from the 2010 Census.
- Generate weighted average of average household sizes and occupancy rates for those blocks, by housing type
- Adjust result to county-wide data from the latest ACS 5-Year Estimates
- Average above result with microdata from PUMs
- Update the county-wide Avg. HH Size and Occ. Rates by housing type in January of each year, based on new ACS data release

New Methods

- Use census data and USPS vacancy data to generate averages of avg. HH size and Occ. rates at the *census tract* level
- Spatially join the tract data to residential address points
- Summarize and spatially join address-based student enrollment data to residential address points
- Overwrite avg. HH size in residential address when enrolled students > avg. HH size
- Generate avg. HH size for apartments separately and apply to all apartment points

Detailed Methods

2020 Census Tracts ($n = 93$)

2020 Census Redistricting Data (April 1, 2020)

- **Occupancy Rate:** [Vacant Units / Housing Units]
- **Households:** [Occupancy Rate * Housing Units]
- **Avg. Household Size:** [Total Pop – Group Quarters Pop] / Households

USPS Vacancy Data (2021 Q4)

- **Occupancy Rate:** [Vacant Units / Housing Units]
- *Data in 2010 Tracts applied twice to 2020 tract splits (10)*

US Census 2015-2019 ACS 5-Year Estimates

- Occupancy Rate, Avg. Household Size

2020 Census Tracts

● Occupancy Rate

Mean

2020 Census P.L. 94-171 Redistricting Data
% Occupied Housing Units

HUD Aggregated USPS Vacancy Data
% Occupied Residential Addresses
2010 tract data applied to 2020 tracts

US Census ACS 5-Year Estimates
% Occupied Housing Units

● Average Household Size

Mean

2020 Census P.L. 94-171 Redistricting data
 $((\text{Total Population} - \text{Group Quarters Population}) / \text{Households}) = \text{Average Household Size}$

US Census ACS 5-Year Estimates
Average Household Size

Detailed Methods

Residential Premise Address Points: 2021 Q2 ($n = 158,706$)

Apartments ($n = 23,130$)

- **Assumptions:** Unlike condos or other multifamily units, apartments have smaller household sizes. Average household size calculated separately for apartments and applied county-wide

Age-Restricted Units ($n = 5,957$)

- **Assumptions:** Avg. Household Size and Occupancy at the tract level accounts for most age-restricted units in the neighborhood

Group Quarters

- **67 Facilities** (2020 Census and internal estimates)
- **Population Estimate: 3,812**

Student Enrollment Data ($90,690$ students at $51,389$ addresses)

- Applied to each household, where applicable
- Avg. household size adjusted where enrolled students is $>$ or $<$

Census tract data spatially joined and applied to each residential unit

Residential Premise Address Points
Maintained and updated by Geospatial Technology Services and the Planning Office

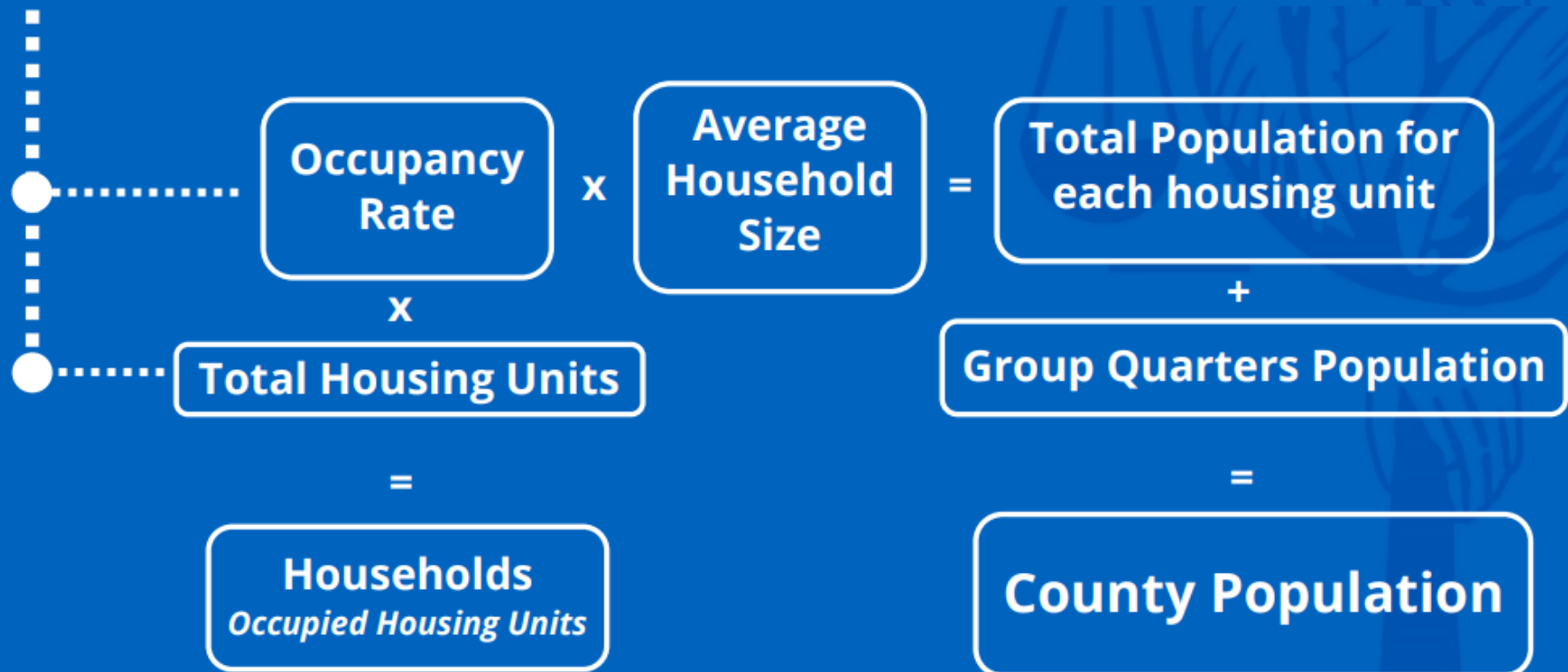
Average household size of residential units bulk updated if < total enrolled students

Summarized by address and spatially joined to residential points

School Enrollment Data
Enrolled students summarized by housing unit. Data from PWC Public Schools Planning Dept.

Average household size of apartment units bulk updated if no enrolled students

US Census ACS Average Household Size for Apartment Units
Mean of weighted average household size of units in buildings with ≥ 2 units (calculated from Table B25124) AND renter-occupied units (lowest bound margin of error)



Detail: Avg. Household Size: Apartments

Table B25124: Tenure By Household Size by Units in Structure

American Community Survey

B25124 | TENURE BY HOUSEHOLD SIZE BY UNITS IN STRUCTURE

2019: ACS 5-Year Estimates Detailed Tables | Universe: Occupied housing units

Notes | 1 Geo | Years | Topics | Surveys | 123 | Hide | Transpose | Margin of Error | Restore | Excel

Prince William County, Virginia		
Label	Estimate	Margin of Error
▼ Total:	142,000	±667
▼ Owner occupied:	104,061	±1,117
▼ 1-person household:	16,362	±780
1, detached or attached	14,502	±737
2 to 4	222	±85
5 to 19	1,052	±201
20 to 49	246	±91
50 or more	172	±69
Mobile home, boat, RV, van, etc.	168	±90
▼ 2-person household:	30,705	±979
1, detached or attached	29,445	±929
2 to 4	209	±106
5 to 19	584	±153

Detail: Avg. Household Size: Apartments

TABLE B25124 Totals:		Persons	Sum	Weight	Weighted Total
1, detached or attached			117,374.0		
	1-person household:	1	16,441.0	0.14	0.14
	2-person household:	2	33,013.0	0.28	0.56
	3-person household:	3	21,710.0	0.18	0.55
	4-person household:	4	24,042.0	0.20	0.82
	5-or-more person household:		22,168.0		
Interpolated	5-person household:	5	12,708.9	0.11	0.54
Interpolated	6-person household:	6	5,294.6	0.05	0.27
Interpolated	7-or-more person household:	7	4,164.4	0.04	0.25
					3.14
2+ units			24,626.0		
	1-person household:	1	9,898.0	0.40	0.40
	2-person household:	2	6,464.0	0.26	0.52
	3-person household:	3	3,542.0	0.14	0.43
	4-person household:	4	2,941.0	0.12	0.48
	5-or-more person household:		1,781.0		
Interpolated	5-person household:	5	1,021.1	0.04	0.21
Interpolated	6-person household:	6	425.4	0.02	0.10
Interpolated	7-or-more person household:	7	334.6	0.01	0.10
					2.24

Detail: Avg. Household Size: Apartments

American Community Survey

B25010 | AVERAGE HOUSEHOLD SIZE OF OCCUPIED HOUSING UNITS BY TENURE

2019: ACS 5-Year Estimates Detailed Tables | Universe: Occupied housing units

Notes | 1 Geo | Years | 2 Topics | Surveys | 123 | Hide | Transpose | Margin of Error | Restore | Excel | Download

Prince William County, Virginia

Label	Estimate	Margin of Error
▼ Average household size --		
▼ Total:	3.22	±0.02
Owner occupied	3.28	±0.03
Renter occupied	3.07	±0.06

Mean

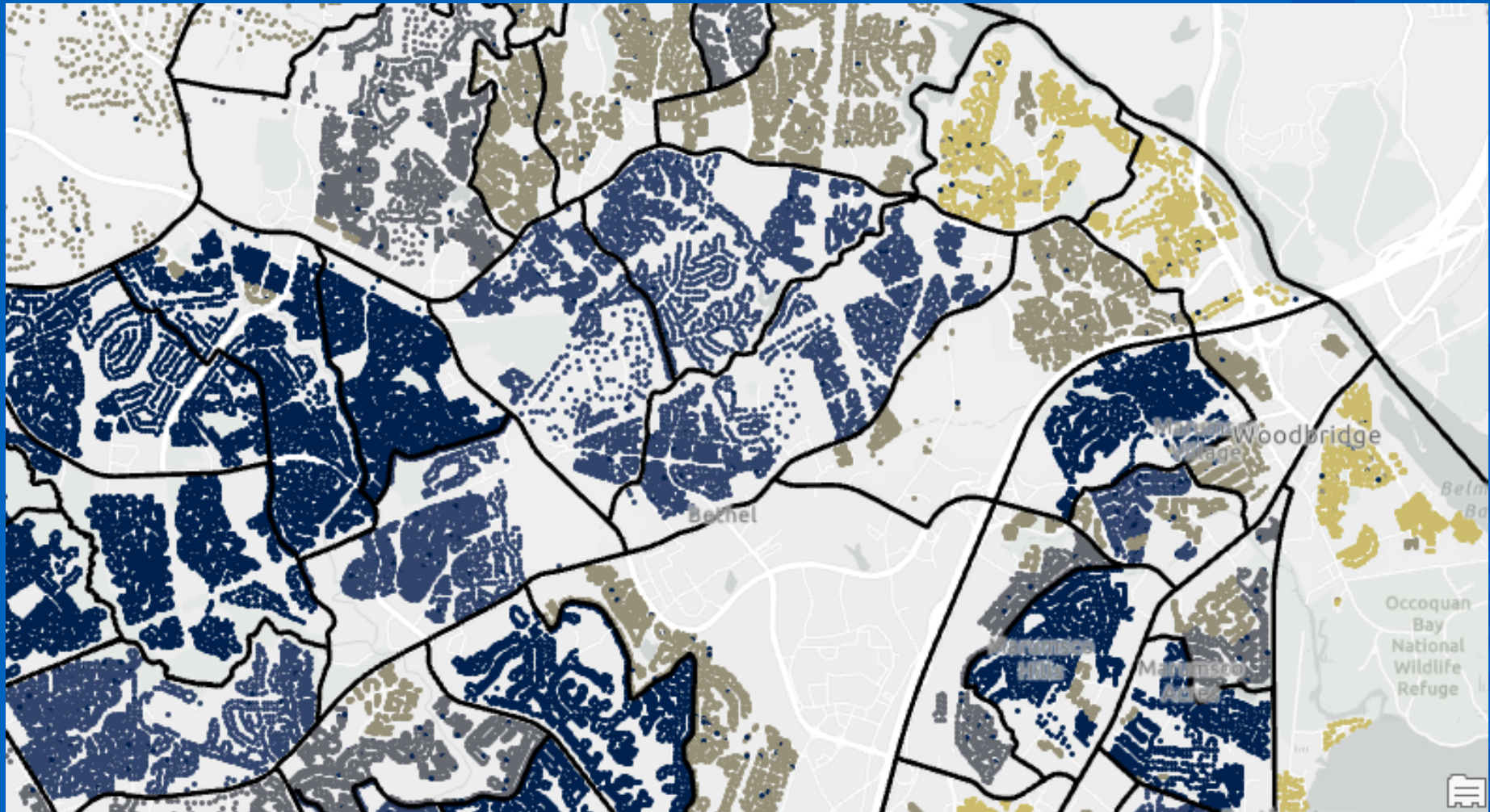
Weighted Avg. HH Size of HH in Structures with 2+ Units (Table B25124 & B25009):
2.24

Average HH Size of Renter Occupied Units (Table B25010):
3.07

= 2.66 persons per apt. unit

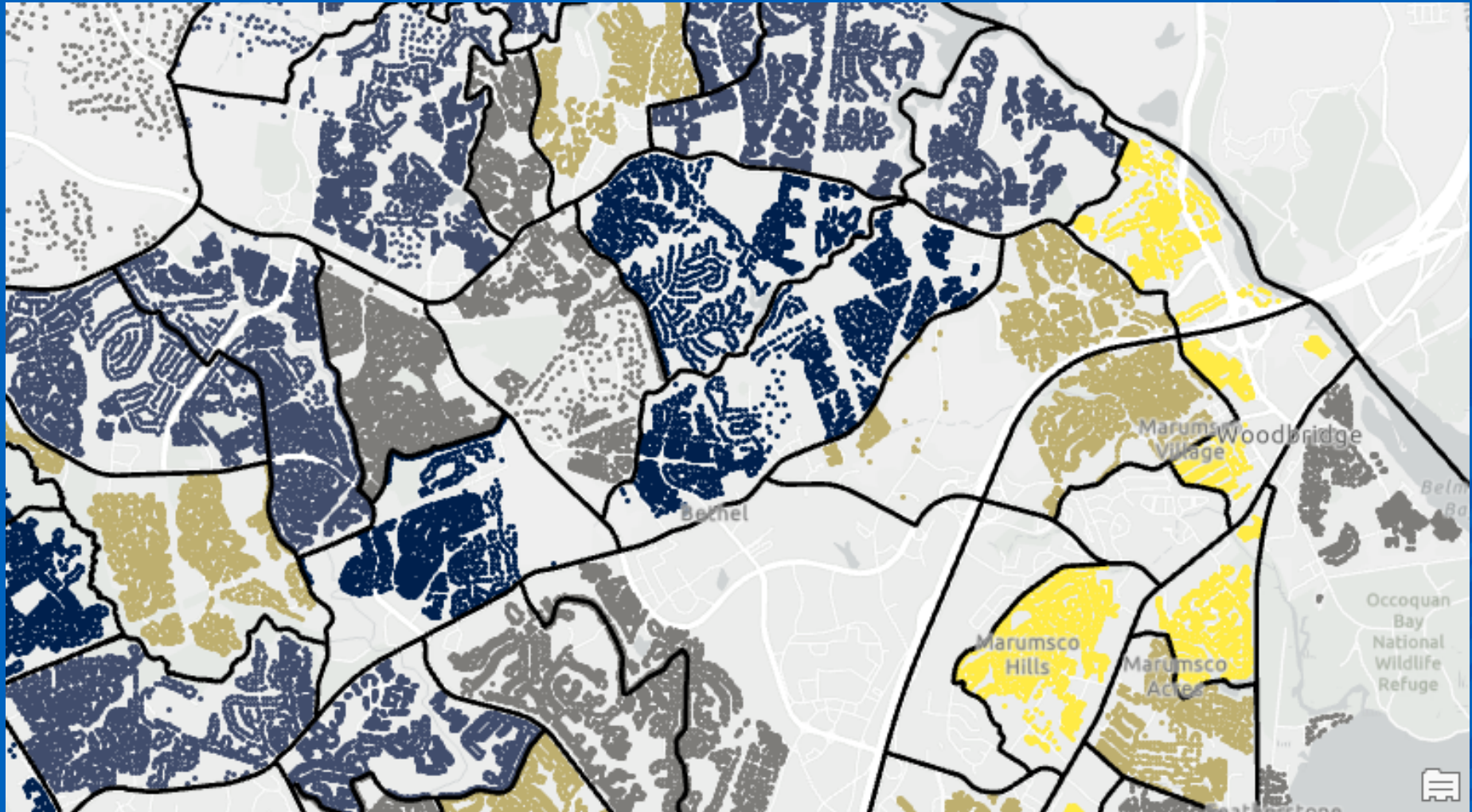
Results

- Average Household Size



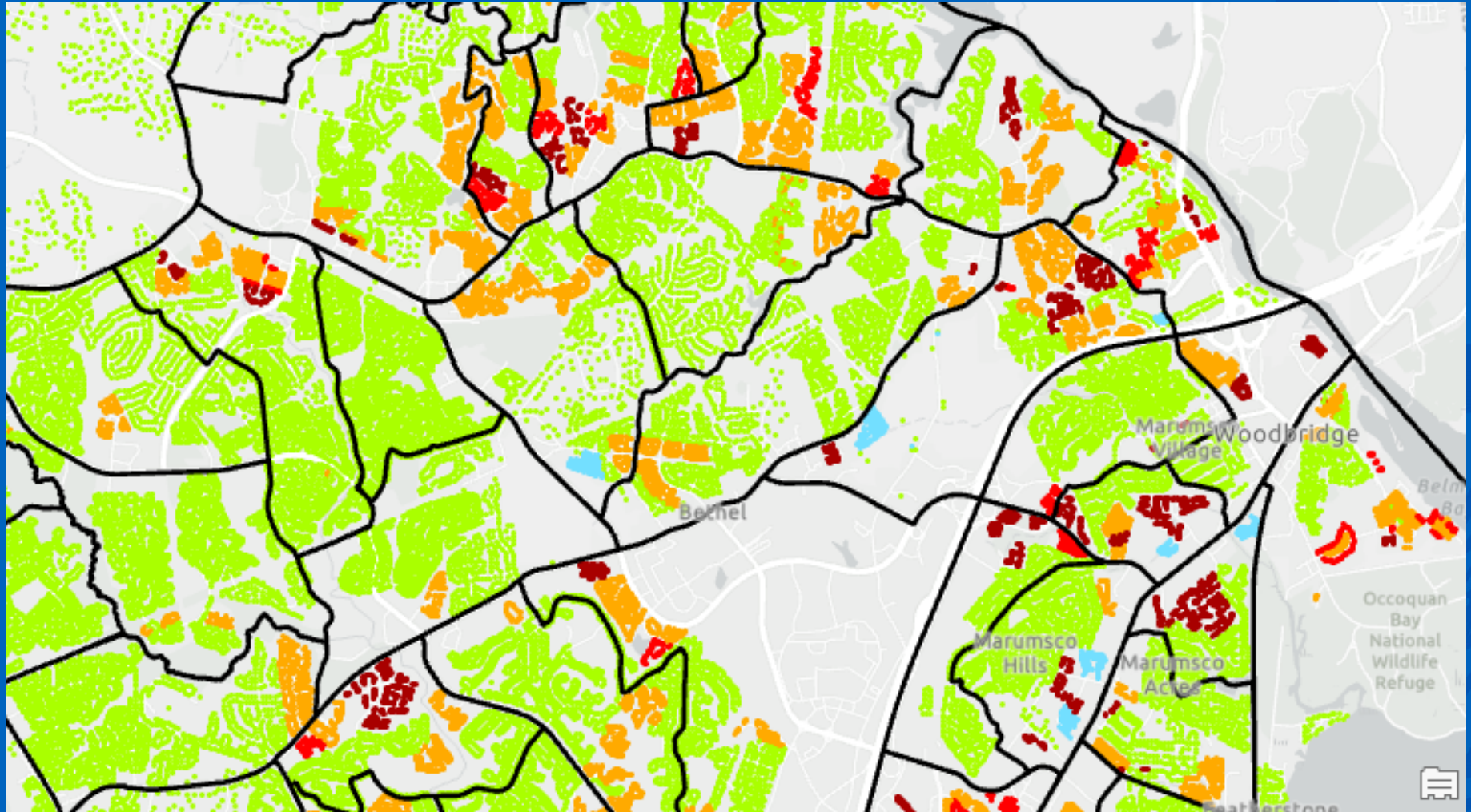
Results

- **Occupancy Rate**



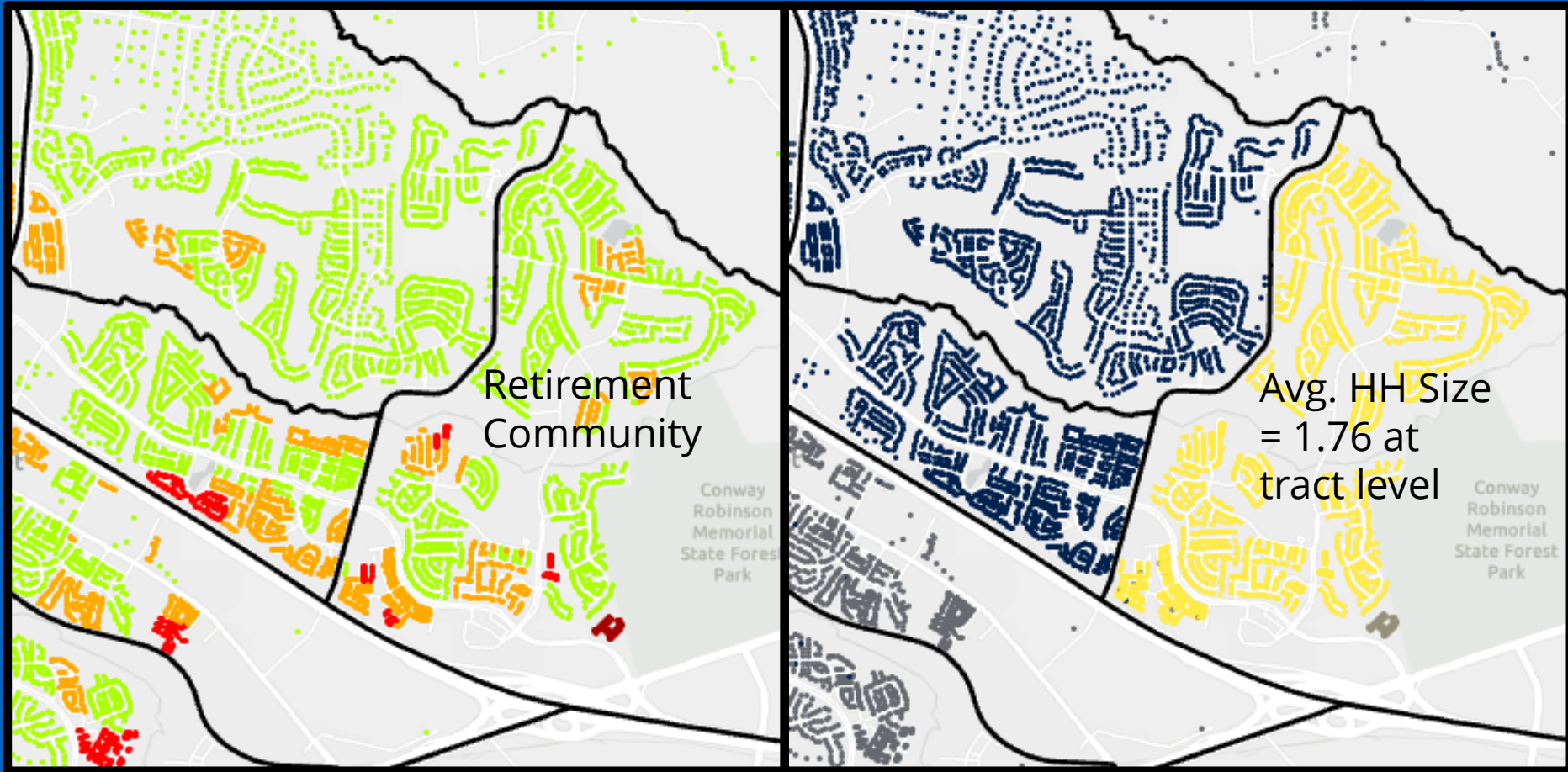
Results

- Housing Unit Type



Results

- Age-Restricted Housing



Results

- Age-Restricted Housing and Enrolled Students



Results

2021: Q2

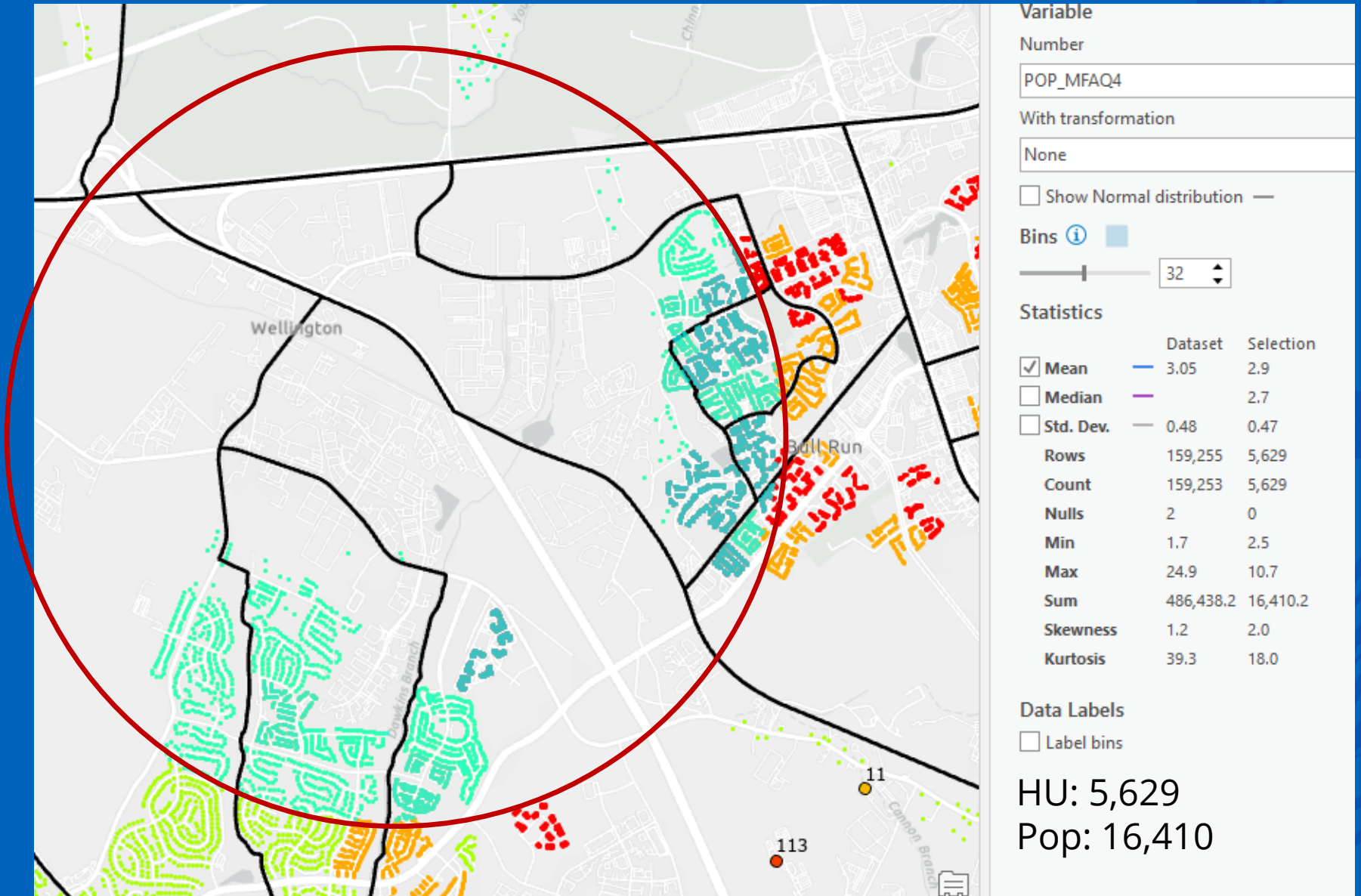
	Housing Units	Housing Units %	Households	Population	Avg. HH Size	Occupancy Rate
Single-Family Detached	85,264	53.5%	83,388	274,957	3.30	97.8%
Single-Family Attached	41,205	25.9%	40,051	125,815	3.14	97.2%
Apartment	327		316	857	2.70	96.5%
Mobile Home Park	1,124	0.7%	1,094	3,643	3.30	97.3%
Multi-Family	31,662	19.9%	30,491	82,024	2.70	96.3%
Apartment	22,805	72.0%	21,916	57,885	2.64	96.1%
Other	8,857	28.0%	8,565	24,139	2.80	96.7%
	159,255		155,024	486,439		
Group Quarters				3,812		
Total Population				490,251		

Results

Decennial Census Data (US Census Bureau)						
	Population	Housing Units	Households	Occupancy Rate	Avg. Household Size	Group Quarters
2000 Census	280,813	98,052	94,570	96.45	2.94	2,389
2010 Census	402,002	137,115	130,785	95.38	3.05	2,520
2020 Census	482,204	158,525	153,745	96.98	3.12	3,018

PWC Biannual Estimates						
	Population	Housing Units	Households	Occupancy Rate	Avg. Household Size	Group Quarters
2020 Q4	486,504	158,010	153,837	97.36	3.14	3,812
2021 Q2	488,629	158,706	154,521	97.36	3.14	3,812
2021 Q4	490,250	159,255	155,014	97.34	3.14	3,812

Results



Advantages:

- **Sharpened Accuracy with addition of external data**
- **Data housed within each residential premise point for on-the-fly household and population calculations for any boundary**
- **Occupancy and household size calculated differently for 93 census tracts instead of uniformly applied across county**

Limitations:

- **Data not applied differently based on housing unit type**
- **Calculations do not include US Census microdata**
- **Calculated and released biannually instead of quarterly**
- **External data sources for average household size are very limited. This data point heavily relies on census data**
- **Difficulty applying detailed data to multi-family complexes**

Next Steps:

- **Continue to sharpen the accuracy of household and population estimates with external data to supplement US Census data.**
- **Develop and conduct annual surveys of multi-family complexes and group quarters facilities to pinpoint total population, occupancy, and avg. household size. Use as a new input into the population estimate model**

Needs:

- **Staff to conduct annual multi-family and group quarters surveys in addition to routine demographic data requests**

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