2021 Vehicle Inventory and Use Survey
Public Use File – Data User Guide

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Introduction

This Data User Guide describes the Public Use File (PUF) created from the data collected for the 2021 Vehicle Inventory and Use Survey (VIUS). It provides a brief description of the VIUS, describes the differences between the VIUS published estimates[1] and the records available in the VIUS PUF, and explains how to create estimates as well as measures of sampling variability using the VIUS PUF data. Readers interested in understanding or analyzing the VIUS PUF data should also familiarize themselves with the content of the 2021 VIUS Methodology[2] to obtain an understanding of the survey, questionnaires, sample design, and other topics relevant to the VIUS.

The VIUS PUF provides data users the ability to create a wider variety of estimates tailored specifically to their data needs. Comments from users regarding the content and usefulness of this data product are appreciated. Contact the VIUS staff by email (ERD.VIUS@census.gov) with your feedback.

About the Vehicle Inventory and Use Survey

The VIUS is a joint effort between the U.S. Department of Transportation's (DOT) Bureau of Transportation Statistics and the U.S. Department of Commerce's Census Bureau, in partnership with the DOT Federal Highway Administration and the U.S. Department of Energy.

The VIUS provides data on the physical and operational characteristics of the nation's truck population. Its primary goal is to produce national- and state-level estimates of the total number of vehicles, vehicle miles, and average miles per vehicle. The target population includes trucks, minivans, vans, and sport utility vehicles (SUVs) registered in the 50 U.S. states and the District of Columbia. Ambulances, buses, motor homes, farm tractors, unpowered trailer units, vehicles disposed of prior to January 1, 2021, and vehicles owned by federal, state, and local governments are excluded.

The VIUS was last conducted in 2002. Additional information on the 2021 VIUS can be found on the U.S. Census Bureau VIUS webpage[3].

VIUS PUF Contents

The VIUS PUF is made available as a SAS dataset and as a comma-separated values (CSV) file. The VIUS PUF includes 168 variables for all vehicle records tabulated by the VIUS – a total of 67,952 records. A vehicle record contributes to tabulations if it is an in-scope unit response[4]. Records that are determined to be out-of-scope to the VIUS (based on response to the survey questions) or records that are not unit responses are not tabulated, and therefore, are not included on the VIUS PUF.

Note: New Hampshire vehicles were not included in the 2021 VIUS data collection; therefore, the VIUS PUF does not include any records for vehicles with New Hampshire registration addresses.

[1] <https://www.census.gov/programs-surveys/vius/data/tables.html>
[2] <https://www.census.gov/programs-surveys/vius/technical-documentation/methodology.html>
[3] <https://www.census.gov/programs-surveys/vius/about.html>
[4] A vehicle record is a *unit response* if the following conditions are met: (1) the respondent reports that the vehicle is still in their possession, or (2) if the vehicle is no longer in the respondent's possession, the respondent reports that the vehicle was disposed of after January 1, 2021.

Detailed information about the variables in the VIUS PUF can be found in the associated data dictionary[5]. The data dictionary includes variable names and descriptions, valid values for each variable, the type and format of each variable, along with an indication of which types of vehicles were eligible to respond to the associated survey question. For instance, if a respondent reported that they did not lease their vehicle, they would not receive questions related to characteristics of a leasing agreement. Where relevant, a data value of X (or .X, if numeric) is used to indicate items that were not collected for a vehicle.

For most variables, a "Not Reported" category is included as a valid value to indicate where a respondent was asked to report a particular item but did not provide a response. Variables sourced from administrative data[6] do not include a "Not Reported" category; similarly, variables where all missing responses were imputed do not include a "Not Reported" category. Variables sourced from administrative data include state provided on vehicle registration (REGSTATE), gross vehicle weight rating code (GVWR_CLASS), number of engine cylinders (CYLINDERS), model year (MODELYEAR), and cubic inch displacement (CUBICINCHDISP). Variables where all missing values were imputed include number of miles driven during 2021 (MILESANNL), number of miles driven since manufactured (MILESLIFE), total length of vehicle configuration (TOTLENGTH), and average weight of vehicle configuration (AVGWEIGHT).

Differences Between Published VIUS Estimates and VIUS PUF Tabulations

To protect the confidentiality of the VIUS respondents, the VIUS uses several disclosure protection techniques when producing estimates of number of vehicles, vehicle miles, and average miles per vehicle. These include aggregation, grouping/recoding rare characteristics and values to data ranges, rounding of estimates, and weighting (i.e., application of sampling, nonresponse adjustment, and post-stratification weights). Details related to these disclosure avoidance techniques can be found in the 2021 VIUS Methodology, linked in footnote 2, above.

For the VIUS PUF, additional measures were taken to protect the confidentiality of the VIUS respondents. These additional measures to protect confidentiality include:

- **Application of noise.** For all records, noise was applied to the number of miles driven during 2021 (MILESANNL), the number of miles driven since manufactured (MILESLIFE), and the tabulation weighting factor (TABWEIGHT).
- **Topcoding.** Extremely large values for the number of miles driven during 2021 (MILESANNL) and the number of miles driven since manufactured (MILESLIFE) were top-coded.
- **Data swapping.** For records with low tabulation weighting factors, values for certain categorical variables were exchanged (i.e., swapped) between records within the same registration state, sampling stratum, and with similar gross vehicle weight rating codes. The following categorical variables were eligible for data swapping: standard features items (ST_*), other features items (OF_*), less-efficient route items (LE_*), and general maintenance items (GM_*). Where applicable, each variable within one of the above-listed series was swapped with values from another record. The tabulation weighting factor threshold for data swapping is kept confidential.
- **Rounding.** All tabulation weighting factors were rounded to the nearest tenth.
- **Additional data coarsening.** For certain categorical variables, categories were combined to limit the possibility of identifying vehicles (or registered vehicle owners) based on rare characteristics. The following VIUS PUF variables were recoded due to disclosure concerns and differ from the categories in the published VIUS tables.

[5] <https://www.census.gov/data/datasets/2021/econ/vius/2021-vius-puf.html>
[6] Administrative data were received from R.L. Polk & Co.; the company derived administrative data using proprietary knowledge and information encoded in the vehicle identification number.

1. Home base state indicator (HBSTATE)
   Published VIUS tables include estimates tabulated by a vehicle's home base state. The VIUS PUF collapses the home base state into four broader categories: home base state is the same as registration state, home base state is outside of the registration state, no home base, not reported.
2. Trailer configuration (TCONFIG)
   Published VIUS tables include estimates tabulated by the number of trailers pulled (single, double, or triple trailers). The VIUS PUF collapses these values into 'one or more trailers pulled'.
3. Total number of axles (PAXLECONFIG)
   Published VIUS tables include estimates tabulated by the number of axles on the vehicle/trailer combination. For vehicles pulling two or three trailers, published estimates are available for 5, 6, 7, 8, 9, and 10 or more axles. In addition to collapsing the number of trailers pulled (as stated above), the VIUS PUF collapses these values for number of axles into one category: '5 axles or more'.
4. Primary product carried (PRIMPROD)
   Published VIUS tables include estimates for the distribution of vehicle miles by product carried. The VIUS PUF includes only one primary product carried for each vehicle. The primary product is the product carried for the greatest percent of the vehicle's loaded mileage; when multiple products had the (same) greatest percentage, the product most-commonly reported at the national level was assigned as the primary product.

In rare instances, variables on the VIUS PUF may include more detailed values than provided on the published VIUS tables. The VIUS PUF provides additional categories for vehicle model year (MODELYEAR) and provides integers – rather than categorical ranges – for miles per gallon (MPG).

These measures were implemented while ensuring, to the extent possible, that estimates produced from the VIUS PUF would be close to the published estimates. The Census Bureau has reviewed this data product to ensure appropriate access, use, and disclosure avoidance protection of the confidential source data (Project No. P-7527235, Disclosure Review Board (DRB) approval number: CBDRB-FY24-0096).

Additional variables included on the VIUS PUF

Several variables are included on the VIUS PUF that do not appear on published VIUS tables. These variables have been requested by users for use in modeling. The following variables are included on the VIUS PUF only:

1. Year when the registered owner took physical possession of the vehicle (ACQUIREYEAR)
2. Type of cab (CABDAY, CAB)
3. Percent of miles driven while loaded (LOADEDPCT)
4. Miles driven since manufactured (MILESLIFE)
5. Number of tires on the rear axle (REARAXLETIRES)
6. Trailer equipment (TE_AEROREF, TE_ALUMWHEEL, TE_FRONTFAIRING, TE_LWLANDGEAR, TE_REARFAIRING, TE_SIDESKIRTS, TE_UCAERODEV, TE_OTHER)
7. Percent of miles driven off road (TRIPOFFROAD)

Variables excluded from the VIUS PUF

Data from selected questions included on the VIUS questionnaires[7] are not provided on either the VIUS published tables or on the VIUS PUF due to poor response quality and/or to protect confidentiality of respondent data. These include:

[7] See the 2021 questionnaires at <https://www.census.gov/programs-surveys/vius/technical-documentation/questionnaires.html>.

1. Items used to determine scope. The VIUS PUF includes in-scope records only; therefore, these scoping variables have the same value for all VIUS PUF records.
    - If the vehicle is still in the respondent's possession
    - If the respondent disposed of the vehicle prior to January 1, 2021
2. Vehicle disposal date and manner of vehicle disposal
3. Reasons (if any) why the vehicle was not in use for periods of 90 consecutive days or more
4. Counts of other vehicles/trailers operated from the home base location
5. How the annual mileage was calculated
6. How the miles-per-gallon was calculated
7. Approximate number of hours that the vehicle was in operation
8. Approximate percentage of vehicle's operating time spent idling
9. Approximate percentage of vehicle's operating time spent using an auxiliary power unit
10. Year the vehicle's engine was last rebuilt/overhauled
11. If the vehicle was used to pull a trailer for less than half of all miles driven
12. Individual trailer information
    - Length of each trailer (single, double, triple) pulled
    - Exterior width of each trailer (single, double, triple) pulled
13. Empty weight of vehicle or vehicle/trailer combination
14. Approximate percentage of vehicle's annual mileage by commercial activity
15. Number of load drop-offs or parcel deliveries made on average in one week
16. Approximate percentage of vehicle's annual mileage where the vehicle was filled to physical capacity (cubed out)
17. Average weight of goods, parcels, or any other products that were loaded for delivery or sale
18. Approximate percentage of vehicle's annual mileage by type of hazardous material carried

Additionally, the registered vehicle owner's name and address, vehicle identification number (VIN), vehicle make, and model are not provided on the VIUS PUF.

Creating Estimates with the VIUS PUF

The VIUS design includes sampling, post-stratification to known contractor-provided totals[8], and adjustments for survey nonresponse; therefore, *tabulation weighting factors **must** be incorporated when producing estimates with the VIUS PUF data*. Additionally, an estimate of sampling variance should be derived for each associated weighted estimate.

How to estimate number of vehicles and annual vehicle miles with the VIUS PUF

To create estimates of the total number of vehicles, sum the tabulation weighting factor over the desired domain:

$$Number\ of\ vehicles_D \quad = \quad \sum_{i \in D} TABWEIGHT_i\ , \qquad [1]$$

where D is the desired domain, $TABWEIGHT$ is the tabulation weighting factor, and i indexes the units in domain D. For example, to estimate the number of vehicles with registration addresses in Maryland, compute the quantity in [1] using records where REGSTATE = MD. Note that the domain does not need to be geographical. To instead estimate the number of vehicles with a crane body type, compute the quantity in [1] using records where BTYPE = 11.

[8] Registered vehicle data and analysis for the VIUS sampling frame was provided by R.L. Polk & Co.

To create estimates of vehicle miles, multiply the annual mileage value by the tabulation weighting factor before summing over the desired domain:

$$Vehicle\ miles_D \quad = \quad \sum_{i \in D} TABWEIGHT_i \cdot MILESANNL_i\ , \qquad [2]$$

where $MILESANNL$ is the number of miles driven during 2021 and D, $TABWEIGHT$, and i are as above.

How to estimate average miles per vehicle with the VIUS PUF

To create estimates of average miles per vehicle over a desired domain, divide the estimate of vehicle miles from [2] by the estimate of number of vehicles from [1]:

$$Average\ miles\ per\ vehicle_D \quad = \quad \frac{\sum_{i \in D} TABWEIGHT_i \cdot MILESANNL_i}{\sum_{i \in D} TABWEIGHT_i}. \qquad [3]$$

The "Weighted PUF Tabulations" columns of Table A1 (APPENDIX A) contain estimates for registration geography derived using formulas [1], [2], and [3]. Sample SAS code for creating estimates can be found in APPENDIX B.

How to estimate coefficients of variation with the VIUS PUF

Coefficients of variation (CVs) are provided as a measure of the sampling error for the published VIUS estimates. The variance formulas used to calculate the published CVs (see 'Sampling Error' in the 2021 VIUS Methodology, linked in footnote 2, above) require proprietary information about the sampling frame which due to confidentiality concerns, are not provided on the PUF. Instead, PUF records have been assigned to one of eight random groups (RGROUP); users are encouraged to use the method of random groups for deriving CVs for weighted PUF tabulations. The following formulas for deriving CVs via the method of random groups[9] are based off those given in Wolter (2007, pp. 21-106).

Calculate replicate totals for each random group. Replicate totals represent a best approximation to the overall estimate using only the units in a specific random group. The replicate total for random group g and domain D can be computed as:

$$\hat{Y}_{D,g} \quad = \quad G\left(\sum_{i \in (D,g)} w_i y_i\right), \qquad [4]$$

where $\hat{Y}_{D,g}$ is the replicate total, G is the number of random groups (= 8 for the VIUS PUF), w_i is the tabulation weighting factor for unit i, and y_i equals one (for number of vehicles) or equals MILESANNL for unit i (for vehicle miles).

Given the replicate totals, the variance for the estimated total, $\hat{Y}_D$ is:

$$v\left(\hat{Y}_D\right) \quad = \quad \frac{1}{G(G-1)} \sum_{g=1}^{G} \left(\hat{Y}_{D,g} - \hat{Y}_D\right)^2. \qquad [5]$$

The CV of an estimate is the square root of the corresponding variance estimate divided by the estimated total, expressed as a percent:

[9] Note: The VIUS did not include any units into the sample with certainty; therefore, certainties are omitted from the variance formulas provided in this document.

$$cv\left(\hat{Y}_D\right) = \frac{\sqrt{v\left(\hat{Y}_D\right)}}{\hat{Y}_D} * 100. \quad [6]$$

The replicate total for average miles per vehicle, a ratio, can be defined by dividing the replicate total for vehicle miles (here, called $\hat{Z}_{D,g}$) by the replicate total for number of vehicles (here, called $\hat{X}_{D,g}$): $\hat{Y}_{D,g} = \hat{Z}_{D,g}/\hat{X}_{D,g}$. Use this ratio in [5] and proceed with [6] to find the CV.

Note: If calculating the variance for an estimate where one (or more) random groups are empty, instead use G equal to the number of non-empty groups. For instance, if a desired estimate of average miles per vehicle has two empty groups, then calculate the values in [4] and [5] with $G = 8 - 2 = 6$ groups. Random groups may be empty when the domain of a desired estimate is small.

Note: If creating confidence intervals for VIUS PUF estimates, use a t-distribution with $G - 1$ degrees of freedom.

The "PUF CVs" columns of Table A2 (APPENDIX A) contain variance estimates for registration geography estimates derived using formulas [4], [5], and [6]. Note that PUF CVs obtained via the method of random groups are often less than the design-based, published CVs.

Example of calculations using the VIUS PUF

In this section, calculations of the weighted PUF estimate and associated CV are shown for the *number of vehicles* with a *wood chipper* body type (here, the domain D is defined as vehicles where BTYPE = 25).

First, use [1] to calculate the weighted *number of vehicles* estimate by summing the tabulation weighting factors for all 71 VIUS PUF records in the desired domain:

$$\hat{Y}_D = \sum_{i \in (BTYPE=25)} TABWEIGHT_i = 13{,}605.8$$

Next, use [4] to compute the replicate total for the *number of vehicles* with a *wood chipper* body type for each of the eight random groups (RGROUP). Below, the calculation for random group 7 is shown; note that there are four VIUS PUF records in domain D where RGROUP = 7.

$$\begin{aligned} \hat{Y}_{D,7} = 8\left(\sum_{i \in (BTYPE=25, g=7)} w_i y_i\right) &= 8\left(\sum_{i \in (BTYPE=25, g=7)} TABWEIGHT_i \cdot 1\right) \\ &= 8(344.3 \cdot 1 + 60.7 \cdot 1 + 161.7 \cdot 1 + 633.3 \cdot 1) \\ &= 9{,}600.0 \end{aligned}$$

Computed using [4], all eight replicate totals for the *number of vehicles* with a *wood chipper* body type are shown, below:

$$\begin{aligned} \hat{Y}_{D,1} &= 13{,}878.4 \\ \hat{Y}_{D,2} &= 14{,}816.0 \\ \hat{Y}_{D,3} &= 8{,}673.6 \end{aligned}$$

$$\hat{Y}_{D,4} = 11{,}824.8$$
$$\hat{Y}_{D,5} = 16{,}628.0$$
$$\hat{Y}_{D,6} = 6{,}910.4$$
$$\hat{Y}_{D,7} = 9{,}600.0$$
$$\hat{Y}_{D,8} = 26{,}515.2$$

Use [5] together with the eight replicate totals to calculate the variance:

$$v(\hat{Y}_D) = \frac{1}{G(G-1)}\sum_{g=1}^{G}(\hat{Y}_{D,g} - \hat{Y}_D)^2$$
$$= \frac{1}{8(8-1)}[(13{,}878.4 - 13{,}605.8)^2 + (14{,}816.0 - 13{,}605.8)^2 + \cdots + (26{,}515.2 - 13{,}605.8)^2]$$
$$= 4{,}744{,}617.3$$

Finally, calculate the CV of the *number of vehicles* with a *wood chipper* body type using [6]:

$$cv(\hat{Y}_D) = \frac{\sqrt{v(\hat{Y}_D)}}{\hat{Y}_D} * 100 = \frac{\sqrt{4{,}744{,}617.3}}{13{,}605.8} * 100$$
$$= 16.0$$

Suggested Citations

Data users who create their own estimates using data from this file should cite the U.S. Census Bureau and the Bureau of Transportation Statistics as the source of the original data only. Users of the VIUS PUF should cite the data and/or documentation using the following citations, updated to include the date the file was accessed, where appropriate:

1. For the VIUS PUF:

U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, U.S. Census Bureau. (December 2023). *2021 Vehicle Inventory and Use Survey Datasets: 2021 VIUS Public Use File (PUF)*. U.S. Department of Transportation, Bureau of Transportation Statistics; U.S. Department of Commerce, U.S. Census Bureau; U.S. Department of Transportation, Federal Highway Administration; U.S. Department of Energy. Accessed *[enter date you accessed/downloaded file here]* from https://www.census.gov/data/datasets/2021/econ/vius/2021-vius-puf.html

2. For this Data User Guide:

U.S. Department of Transportation, Bureau of Transportation Statistics and U.S. Department of Commerce, U.S. Census Bureau. (December 2023). *2021 Vehicle Inventory and Use Survey Public Use File – Data User Guide.* Retrieved from: https://www2.census.gov/programs-surveys/vius/datasets/2021/vius_2021_puf_user_guide.pdf

References

Wolter, K. M. (2007). *Introduction to Variance Estimation: Second Edition.* New York: Springer-Verlag.

APPENDIX A: Comparison of Estimates/CVs Produced Using the Public Use File and Published Estimates/CVs

Table A1.

Comparison of Weighted PUF Tabulations and Published VIUS Estimates – By Registration Geography

Registration geography	Number of PUF records	Weighted PUF Tabulations – Unrounded			Weighted PUF Tabulations – Rounded			Published Estimates		
		Number of vehicles	Vehicle miles	Average miles per vehicle	Number of vehicles (thousands)	Vehicle miles (millions)	Average miles per vehicle (thousands)	Number of vehicles (thousands)	Vehicle miles (millions)	Average miles per vehicle (thousands)
United States[†]	67,952	179,817,852	1,896,992,660,361	10,550	179,817.9	1,896,992.7	10.6	180,066.7	1,896,994.9	10.5
Alabama	1,337	3,038,660	34,757,257,733	11,438	3,038.7	34,757.3	11.4	3,040.8	34,757.3	11.4
Alaska	1,045	488,218	3,972,447,808	8,137	488.2	3,972.4	8.1	485.1	3,972.5	8.2
Arizona	1,158	4,839,466	47,457,906,435	9,806	4,839.5	47,457.9	9.8	4,821.5	47,457.9	9.8
Arkansas	1,418	1,837,141	20,612,315,507	11,220	1,837.1	20,612.3	11.2	1,841.6	20,612.3	11.2
California	751	19,469,798	193,803,031,858	9,954	19,469.8	193,803.0	10.0	19,684.2	193,802.7	9.8
Colorado	1,335	3,750,049	33,496,153,203	8,932	3,750.0	33,496.2	8.9	3,762.5	33,496.2	8.9
Connecticut	1,533	1,746,483	18,024,603,422	10,321	1,746.5	18,024.6	10.3	1,747.0	18,024.6	10.3
Delaware	1,182	548,403	5,739,744,731	10,466	548.4	5,739.7	10.5	547.3	5,739.7	10.5
District of Columbia	470	141,151	1,213,644,762	8,598	141.2	1,213.6	8.6	141.9	1,213.6	8.6
Florida	1,319	10,187,435	115,001,715,999	11,289	10,187.4	115,001.7	11.3	10,217.0	115,001.5	11.3
Georgia	1,197	6,094,115	68,683,711,706	11,270	6,094.1	68,683.7	11.3	6,087.6	68,683.5	11.3
Hawaii	1,265	726,655	6,868,330,992	9,452	726.7	6,868.3	9.5	726.0	6,868.3	9.5
Idaho	1,507	1,315,296	11,373,408,235	8,647	1,315.3	11,373.4	8.6	1,309.2	11,373.4	8.7
Illinois	1,464	6,299,588	70,347,857,949	11,167	6,299.6	70,347.9	11.2	6,331.0	70,347.9	11.1
Indiana	1,329	4,360,139	57,823,306,894	13,262	4,360.1	57,823.3	13.3	4,348.1	57,823.3	13.3
Iowa	1,714	2,194,605	25,448,859,110	11,596	2,194.6	25,448.9	11.6	2,201.8	25,448.8	11.6
Kansas	1,369	1,887,955	20,153,444,544	10,675	1,888.0	20,153.4	10.7	1,881.7	20,153.5	10.7
Kentucky	1,446	2,716,724	31,415,240,244	11,564	2,716.7	31,415.2	11.6	2,718.9	31,415.2	11.6
Louisiana	1,124	2,584,952	30,775,258,274	11,906	2,585.0	30,775.3	11.9	2,580.1	30,775.2	11.9
Maine	1,551	891,167	8,611,237,345	9,663	891.2	8,611.2	9.7	890.5	8,611.2	9.7
Maryland	1,385	3,197,849	31,299,682,549	9,788	3,197.8	31,299.7	9.8	3,197.2	31,299.8	9.8
Massachusetts	1,494	3,437,273	37,396,653,135	10,880	3,437.3	37,396.7	10.9	3,430.8	37,396.6	10.9
Michigan	1,484	5,884,455	67,282,604,344	11,434	5,884.5	67,282.6	11.4	5,891.6	67,282.6	11.4
Minnesota	1,580	3,580,818	41,092,661,462	11,476	3,580.8	41,092.7	11.5	3,594.5	41,092.7	11.4
Mississippi	1,078	1,856,421	22,655,875,914	12,204	1,856.4	22,655.9	12.2	1,856.5	22,656.0	12.2
Missouri	1,530	3,728,760	42,412,686,756	11,374	3,728.8	42,412.7	11.4	3,738.3	42,412.7	11.3
Montana	1,322	941,502	8,219,719,213	8,730	941.5	8,219.7	8.7	945.3	8,219.7	8.7
Nebraska	1,481	1,357,185	15,544,155,448	11,453	1,357.2	15,544.2	11.5	1,357.0	15,544.1	11.5
Nevada	1,216	1,469,761	13,570,007,601	9,233	1,469.8	13,570.0	9.2	1,469.9	13,570.0	9.2
New Jersey	1,205	3,984,250	41,253,800,183	10,354	3,984.3	41,253.8	10.4	3,959.6	41,253.7	10.4

[†] Excluding New Hampshire.

Registration geography	Number of PUF records	Weighted PUF Tabulations – Unrounded			Weighted PUF Tabulations – Rounded			Published Estimates		
		Number of vehicles	Vehicle miles	Average miles per vehicle	Number of vehicles (thousands)	Vehicle miles (millions)	Average miles per vehicle (thousands)	Number of vehicles (thousands)	Vehicle miles (millions)	Average miles per vehicle (thousands)
New Mexico	1,244	1,312,766	10,703,454,611	8,153	1,312.8	10,703.5	8.2	1,310.8	10,703.5	8.2
New York	1,418	6,352,533	62,184,597,974	9,789	6,352.5	62,184.6	9.8	6,367.9	62,184.5	9.8
North Carolina	1,418	6,111,973	67,676,746,806	11,073	6,112.0	67,676.7	11.1	6,111.7	67,676.8	11.1
North Dakota	1,526	627,196	6,676,397,152	10,645	627.2	6,676.4	10.6	625.8	6,676.4	10.7
Ohio	1,514	6,686,220	68,123,635,536	10,189	6,686.2	68,123.6	10.2	6,690.0	68,123.5	10.2
Oklahoma	1,110	2,907,454	35,704,140,898	12,280	2,907.5	35,704.1	12.3	2,886.6	35,704.2	12.4
Oregon	1,516	2,381,545	19,790,437,601	8,310	2,381.5	19,790.4	8.3	2,393.5	19,790.4	8.3
Pennsylvania	1,941	7,196,867	75,656,458,986	10,512	7,196.9	75,656.5	10.5	7,194.8	75,656.3	10.5
Rhode Island	1,213	431,537	4,343,000,939	10,064	431.5	4,343.0	10.1	430.8	4,346.1	10.1
South Carolina	1,289	3,153,140	35,105,325,811	11,133	3,153.1	35,105.3	11.1	3,159.1	35,105.4	11.1
South Dakota	1,478	700,569	6,478,811,379	9,248	700.6	6,478.8	9.2	701.9	6,478.9	9.2
Tennessee	1,378	4,221,229	44,823,219,131	10,619	4,221.2	44,823.2	10.6	4,235.6	44,823.2	10.6
Texas	1,104	16,972,801	175,033,195,234	10,313	16,972.8	175,033.2	10.3	16,956.0	175,033.2	10.3
Utah	1,400	1,833,968	21,068,475,328	11,488	1,834.0	21,068.5	11.5	1,835.2	21,068.5	11.5
Vermont	1,482	399,418	4,234,492,851	10,602	399.4	4,234.5	10.6	397.7	4,234.5	10.6
Virginia	1,544	4,466,804	41,880,813,009	9,376	4,466.8	41,880.8	9.4	4,475.6	41,880.7	9.4
Washington	1,528	4,282,724	36,709,130,234	8,571	4,282.7	36,709.1	8.6	4,271.1	36,709.2	8.6
West Virginia	1,463	1,107,007	10,711,171,829	9,676	1,107.0	10,711.2	9.7	1,104.8	10,711.1	9.7
Wisconsin	1,681	3,615,049	39,501,680,723	10,927	3,615.0	39,501.7	10.9	3,608.6	39,501.5	10.9
Wyoming	1,416	500,779	4,280,150,972	8,547	500.8	4,280.2	8.5	504.7	4,280.1	8.5

Table A2.

Comparison of VIUS PUF Coefficients of Variation (CVs) and Published CVs – By Registration Geography

Registration geography	PUF CVs			Published CVs		
	Number of vehicles	Vehicle miles	Average miles per vehicle	Number of vehicles	Vehicle miles	Average miles per vehicle
United States[†]	0.3	1.1	1.2	0.3	1.2	1.2
Alabama	1.0	5.0	4.7	1.7	5.4	5.1
Alaska	0.7	4.3	4.5	1.7	6.5	6.3
Arizona	1.0	7.9	7.3	1.8	5.8	5.6
Arkansas	0.9	4.5	3.8	1.3	5.0	4.8
California	1.4	5.8	6.6	1.3	7.3	7.2
Colorado	0.4	5.8	5.8	1.2	4.0	3.9
Connecticut	0.9	2.0	2.6	1.2	4.4	4.2
Delaware	1.4	5.5	5.1	1.8	5.9	5.7
District of Columbia	3.0	5.1	3.4	1.3	6.3	6.1
Florida	1.1	5.0	4.7	1.4	4.3	4.1
Georgia	1.7	4.8	3.5	1.2	5.8	5.7
Hawaii	0.8	6.3	6.6	1.4	7.1	6.9
Idaho	0.9	4.7	4.6	1.2	4.8	4.7
Illinois	1.3	2.9	3.2	1.5	4.4	4.2
Indiana	1.2	3.9	3.6	0.8	4.0	4.0
Iowa	1.1	5.5	5.2	1.2	4.8	4.6
Kansas	0.5	2.1	2.1	1.2	4.6	4.5
Kentucky	0.9	10.4	10.0	1.0	6.7	6.6
Louisiana	1.6	4.1	3.9	1.3	5.4	5.3
Maine	0.6	4.4	4.1	1.3	5.4	5.2
Maryland	0.9	8.1	8.0	1.4	6.4	6.3
Massachusetts	1.2	5.5	4.8	1.0	4.6	4.5
Michigan	1.3	5.3	6.1	1.4	5.7	5.6
Minnesota	0.6	2.7	2.5	0.9	4.9	4.9
Mississippi	1.5	3.7	4.2	1.2	5.5	5.4
Missouri	0.6	3.7	3.7	1.0	4.4	4.3
Montana	1.3	4.3	4.2	1.2	5.1	4.9
Nebraska	0.7	3.0	3.1	1.4	4.1	4.0
Nevada	0.8	5.5	5.5	1.3	5.9	5.8
New Jersey	1.0	7.0	6.8	1.3	6.1	6.0
New Mexico	0.7	8.6	8.7	1.2	6.5	6.4
New York	1.2	6.8	6.4	1.5	6.6	6.5
North Carolina	1.1	3.4	3.6	0.9	4.4	4.3
North Dakota	0.8	4.7	3.9	1.4	4.8	4.7
Ohio	0.7	3.8	3.4	1.6	5.4	5.1
Oklahoma	1.2	9.3	8.7	2.2	9.9	9.6
Oregon	0.4	5.2	5.1	1.2	5.1	4.9
Pennsylvania	0.8	4.4	4.5	1.2	3.9	3.8
Rhode Island	1.3	4.8	4.4	1.5	5.0	4.8
South Carolina	0.7	4.2	4.2	1.6	6.4	6.2
South Dakota	0.6	4.5	4.4	1.2	4.4	4.2
Tennessee	0.6	4.1	4.4	1.5	4.6	4.4
Texas	1.4	6.2	6.6	1.1	6.2	6.1
Utah	0.8	5.3	5.0	1.0	4.7	4.6
Vermont	1.1	3.6	3.9	1.2	4.2	4.0
Virginia	0.3	2.7	2.5	1.1	4.4	4.3
Washington	0.6	2.8	2.9	1.0	4.1	4.0
West Virginia	0.5	4.3	4.4	1.0	4.7	4.6
Wisconsin	0.6	3.7	3.6	1.3	4.3	4.1
Wyoming	1.2	4.8	5.0	1.1	5.1	5.1

[†] Excluding New Hampshire.

APPENDIX B: Sample SAS Code

Sample SAS code is provided, below, to compute weighted estimates such as those in the "Weighted PUF Tabulations" columns of Table A1 and associated variance estimates in the "PUF CVs" columns of Table A2.

```
*Define the variables for the desired weighted PUF estimates and variance estimates.;
%let BYVARS = <variables>;

*Calculate replicate totals for each random group.;
proc summary data = <libname>.vius_2021_puf sumwgt sum missing noprint;
   class &BYVARS. RGROUP;
   var MILESANNL;
   weight TABWEIGHT;
   output out = temp(drop = _type_) sumwgt = NUMVEH sum = VEHMIL;
quit;

data ESTIMATE_TOTALS REPLICATE_TOTALS;
   set temp;
   if RGROUP = "" then output ESTIMATE_TOTALS;
   else                output REPLICATE_TOTALS;
run;

   *Calculate G = the number of non-empty groups in each replicate.;
   proc sql;
      create table COUNTG as
      select *, count(RGROUP) as G
      from REPLICATE_TOTALS
      group by %sysfunc(tranwrd(&BYVARS.,%str( ),%str(, )))
      order by %sysfunc(tranwrd(&BYVARS.,%str( ),%str(, ))), RGROUP;
   quit;

   *Merge in total estimates.  Calculate final replicate totals.  Then calculate the square of each REPTOT – TOT.;
   proc sort data = ESTIMATE_TOTALS; by &BYVARS.; run;

   data REPS;
      merge COUNTG(in=a) ESTIMATE_TOTALS(keep = &BYVARS. NUMVEH VEHMIL in=b
      rename=(NUMVEH=NUMVEH_TOT VEHMIL=VEHMIL_TOT));
      by &BYVARS.;
      AVGMIL_TOT = VEHMIL_TOT / NUMVEH_TOT;

      NUMVEH_REPTOT = G*NUMVEH;
      VEHMIL_REPTOT = G*VEHMIL;
      AVGMIL_REPTOT = VEHMIL_REPTOT / NUMVEH_REPTOT;

      NUMVEH_SQ = (NUMVEH_REPTOT - NUMVEH_TOT)**2;
      VEHMIL_SQ = (VEHMIL_REPTOT - VEHMIL_TOT)**2;
      AVGMIL_SQ = (AVGMIL_REPTOT - AVGMIL_TOT)**2;
   run;

*Calculate the variance and CV estimates.  Output the final weighted tabulations and associated CVs.;
proc summary data = REPS sum missing noprint nway;
   class &BYVARS.;
   var NUMVEH_SQ VEHMIL_SQ AVGMIL_SQ;
   output out = REPS2(drop=_TYPE_) sum=;
run;

data FINAL_WGT_EST;
   retain &BYVARS. NUMRECORDS NUMVEH NUMVEH_CV VEHMIL VEHMIL_CV AVGMIL AVGMIL_CV;
   merge REPS2(in=a rename=(_FREQ_=G)) ESTIMATE_TOTALS(in=b drop=RGROUP
   rename=(_FREQ_=NUMRECORDS));
```

```
   by &BYVARS.;
   AVGMIL = VEHMIL / NUMVEH;

   NUMVEH_VAR = (1/(G*(G-1)))*NUMVEH_SQ;
   VEHMIL_VAR = (1/(G*(G-1)))*VEHMIL_SQ;
   AVGMIL_VAR = (1/(G*(G-1)))*AVGMIL_SQ;

   NUMVEH_CV = sqrt(NUMVEH_VAR)/NUMVEH * 100;
   VEHMIL_CV = sqrt(VEHMIL_VAR)/VEHMIL * 100;
   AVGMIL_CV = sqrt(AVGMIL_VAR)/AVGMIL * 100;
   keep &BYVARS. NUMRECORDS NUMVEH NUMVEH_CV VEHMIL VEHMIL_CV AVGMIL AVGMIL_CV;
   format NUMRECORDS NUMVEH VEHMIL AVGMIL comma20. NUMVEH_CV VEHMIL_CV AVGMIL_CV best6.1;
run;
```