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North Carolina State University Institute for Transportation Research and Education

2021 TRIANGLE REGION HOUSEHOLD TRAVEL SURVEY

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LIST OF ABBREVIATIONS

ABS	Address-Based Sample
ACS	American Community Survey
CAMPO	Capital Area Metropolitan Planning Organization
CBS	Convenience-Based Sample
DCHC-MPO	Durham–Chapel Hill–Carrboro Metropolitan Planning Organization
HH	Household
HTS	Household Travel Survey
MSG	Marketing Systems Group
NCDOT	North Carolina Department of Transportation
NCSU-ITRE	North Carolina State University Institute for Transportation Research and Education
PII	Personally Identifiable Information
PUMS	Public Use Microdata Sample
TAC	Technical Advisory Committee
TRM	Triangle Regional Model

ACKNOWLEDGEMENTS

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STUDY SPONSORS

- North Carolina Department of Transportation (NCDOT)
- Capital Area Metropolitan Planning Organization (CAMPO)
- Durham–Chapel Hill–Carrboro Metropolitan Planning Organization (DCHC-MPO)
- GoTriangle

1.0 INTRODUCTION

The North Carolina State University Institute for Transportation Research and Education (NCSU-ITRE) and RSG conducted the 2021 Triangle Travel Survey to collect current information about household and individual travel patterns for residents throughout the greater Raleigh-Durham region, also known as the Triangle region. This study built on many aspects of the 2016 and 2018 Triangle Region Household Travel Surveys, as referenced throughout this report.

A total of 1,120 households (HHs) in the Triangle region completed the survey. These households provided data critical for updating and developing the Triangle Regional Model (TRM). NCSU-ITRE led the project. The technical advisory committee (TAC) for the study was composed of representatives from the North Carolina Department of Transportation (NCDOT), GoTriangle (a regional public transit agency), the Capital Area Metropolitan Planning Organization (CAMPO), and the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC-MPO). RSG served as the primary consultant for the 2021 HTS. Wilkins Research, the study call center, assisted as a subconsultant to RSG.

1.1 STUDY TIMELINE

Survey Design (Sample planning, survey / website programming, invitation development)	**February–June 2020, November 2020–February 2021**
Data Collection (Sending invitations, data monitoring and adjustments)	**February–April 2021**
Data Preparation (Data cleaning and weighting, final reporting)	**April–June 2021**

1.2 STUDY OVERVIEW

The 2021 HTS collected data from February 23, 2021 through April 1, 2021. The study objective was to collect data from at least 1,100 households in the 10-county greater Triangle region (1,000 households throughout the region plus 100 additional households in 20 Census block groups of interest in the DCHC-MPO region). 40,000 households received invitation letters by mail.[1] An additional 1,010 households from the 2018 HTS were invited to the 2021 survey by e-mail to boost total response (described in more detail below). A total of 1,120 households completed the survey (including those in the additional sample requested by the DCHC-MPO).

Table 1 summarizes participation by county, based on sample home address locations. Only three counties (Durham, Orange, and Wake) are entirely included within the TRM region. Portions of seven additional counties are also included in the model region. It is important to keep in mind when reviewing county-level results that only households in block groups that are completely within or that intersect the model region were invited to participate in the survey.

TABLE 1: 2021 HTS PARTICIPATION SUMMARY

County	PUMS[2] HHs	Invited HHs (ABS[3])	Invited HHs (CBS[4])	Recruited HHs	Completed HHs	Recruited HHs Completed Rate[5]	Response Rate[6]	Sample Rate[7]
Durham	131,140	10,464	193	490	296	60.4%	2.8%	0.2%
Orange	55,253	3,970	114	257	155	60.3%	3.8%	0.3%
Wake	419,363	18,922	585	967	561	58.0%	2.9%	0.1%
Chatham	17,438	900	26	41	24	58.5%	2.6%	0.1%
Franklin	24,498	963	16	36	19	52.8%	1.9%	0.1%
Granville	13,758	511	6	12	3	25.0%	0.6%	0.0%
Harnett	15,865	700	9	19	4	21.1%	0.6%	0.0%
Johnston	62,157	2,856	49	90	50	55.6%	1.7%	0.1%
Nash	2,819	61	0	0	0	0.0%	0.0%	0.0%
Person	12,546	653	12	19	8	42.1%	1.2%	0.1%
Total	**754,837**	**40,000**	**1,010**	**1,931**	**1,120**	**58.0%**	**2.7%**	**0.1%**

[1] The original sample plan (developed in spring 2020) included invitations to 30,000 households. RSG increased this number to 40,000 households (with the same 1,100 household target) based on observed lower response rates in other regions during the fall of 2020 due to COVID-19.
[2] 2019 American Community Survey Public Use Microdata Survey 1-Year Estimates for the portion of each county that is in the study area.
[3] Address-Based Sample
[4] Convenience-Based Sample
[5] Recruited HHs Completion Rate = Completed HHs ÷ Recruited HHs
[6] Response Rate = Completed HHs ÷ Invited HHs
[7] Sample Rate = Completed HHs ÷ ACS HHs

The overall response rate of 2.7% reflects a decrease of approximately 45% from 2018 response rates. This decrease – due in part to COVID-19 – is consistent with HTS response trends observed in other regions during the same time period.

1.3 KEY STUDY DESIGN CHANGES IN 2021 (COMPARED TO 2016 AND 2018)

Study Data Collection Methods

The 2021 HTS introduced a seven-day smartphone-app travel diary survey as a second primary method of data collection in addition to the one-day online travel diary survey (used in 2016 and 2018). Like previous years, households could also complete the survey via phone by calling a call center.

Participation via the smartphone app, RSG's rMove™ app, was offered to households in which all related adults reported owning smartphones. Approximately 40% of households in the final sample completed their study participation using rMove. This shift to 7-day smartphone data collection resulted in significantly higher data volume per household compared to previous years of data collection.

Study Sampling Methods

While declining response has been a reality of survey research in recent decades, survey response rates have declined more noticeably in the past 2-3 years. This decline can be attributed to variety of factors, including heightened data privacy concerns, government distrust, survey fatigue, and more recently the COVID-19 pandemic. In 2016 and 2018, the original sample plan was sufficient to achieve sample targets, but additional risk mitigation steps were necessary in 2021 due to COVID-19 impacts on response. RSG took the following steps to ensure the 2021 Triangle Travel Survey met the overall sample target of 1,100 households:

- Increased mailed invitation rate from 30,000 to 40,000 households compared to the original sample plan and invitation counts in 2018 (which had the same sample target).
- Re-invited households from 2018 to take the 2021 survey to increase total completed households. These convenience-based sample households are included in a separate column from address-based sample households in Table 1.
- Extended data collection period by one week to allow more response.
- Added survey reminders to encourage survey retention. (In 2018, survey reminders were turned off in the final weeks of the study to *reduce* response.)

- Added language to website and survey invitations to explain to participants why the survey is still valuable during COVID-19.

RSG estimates that these combined steps yielded an additional 350 households beyond what would have been achieved using just the original sample plan.

2.0 SURVEY DESIGN

2.1 OVERVIEW

A Household Travel Survey (HTS) seeks to obtain data that represent the travel-behavior characteristics of the region and the demographics associated with travelers. This demographic information helps explain variations in travel patterns and allows for data weighting, as described in Chapter 6.0 of this report.

The 2021 survey included two sections:

- **Recruit survey**: This section collected key household-, person-, and vehicle-level information (e.g., number of household members, household-member employment status, and vehicle make/model/year). Only one household member was required to complete the recruit survey (providing information on all other household members). After completing this section, participants were offered the option to complete the travel diary online for one day or using the rMove smartphone app for seven days. Based on their selection, participants were then assigned a travel date or travel week.
- **Travel diary**: This section collected all location-based, trip-level, and travel-day information, as well as certain supplementary person- or household-level information (e.g., trip purpose and mode, telecommute time on travel day, residence type). All household members related to the member who completed the recruit survey ("person 1") were required to complete the travel diary to complete the study. Persons whose relationship to person 1 was roommate, friend, or household help were not asked to complete a travel diary.[8]

2.2 TRAVEL DATE ASSIGNMENT

Households were assigned to a travel date or travel week after completing the recruit survey.

Households that participated via the one-day online travel diary were assigned to report travel on the next Tuesday, Wednesday, or Thursday. Beginning on March 5, 2021, RSG integrated additional travel date assignment balancing online survey households to ensure a more even distribution across days of the week. Using this new balancing method, online survey

[8] NCSU-ITRE and RSG decided not to require travel diaries from roommates, friends, and household help for two primary reasons. First, travel patterns between these types of household members are less correlated than between related household members. Second, RSG has observed that these types of households are less likely to meet the household completion criteria due to the nature of these relationships and the relative difficulty of getting all non-related household members to participate in the survey. Under a design in which all household members are asked to participate, households in which a non-related member does not complete would be completely excluded from the final dataset, whereas this approach enables more of (and more members of) these households to be eligible for inclusion in the final dataset.

households were assigned to an upcoming Tuesday, Wednesday, or Thursday based on a weighted probability.

Households that participated via the seven-day smartphone-app travel diary were assigned to report travel for a full, consecutive week beginning three days after completing the recruit survey (or one day after completing the recruit survey for one-person households). One adult in each rMove household was also selected to report children's travel for one day (reported "by proxy"). The proxy travel day for all rMove household children was the second weekday of the travel period.

2.3 RECRUITMENT AND RETRIEVAL METHODS

RSG used both probability (address-based sampling or ABS) and non-probability (email) sampling methods to recruit respondents into the 2021 HTS. ABS respondents were recruited by invitation materials sent through the United States Postal Service. Email respondents were recruited using the list of emails from households that completed the 2018 HTS and agreed to be contacted again in the future.

In addition to the online and smartphone app participation methods, participants could also complete the survey by telephone. Wilkins Research was responsible for all telephone communications for the 2018 and 2021 HTS. Wilkins has highly trained staff to conduct objective, professional telephone surveys while capturing respondents' answers as fully as possible. RSG provided phone scripts for operators and training reference documents. Operators administered the survey verbally using the online survey instrument.

2.4 SURVEY INCENTIVES

An incentive was offered to all households that completed the survey. Respondents who completed the survey via the online survey instrument received one $10 gift card per household, while respondents who completed the survey via the smartphone app received one $20 gift card per adult participant. Both amounts were printed on the invitation materials and were outlined in the question asking whether the household would like to complete the survey online or via rMove. Households could choose between Amazon or Walmart gift cards (sent via e-mail). Alternatively, households could opt not to receive any gift for participation.

3.0 SURVEY SAMPLING

The primary goal of the 2021 HTS was to collect travel behavior data from a representative set of households in the study region to update the regional transportation model. The sampling plan (in conjunction with post-data-collection weighting and expansion) supported that goal by 1) identifying key geographic, demographic, and travel characteristic segments and 2) determining sampling targets and response rates for these segments.

The sampling targets for certain segments were higher than those for the general population. This enabled sufficient data collection for households demonstrating certain behaviors (e.g., non-auto commuters) and ensured proper representation in the sample along various demographic factors relevant to modeling travel behavior.

As noted above, the study team used both probability[9] (ABS) and non-probability (email) sampling methods to reach the sample targets for the 2021 HTS. The majority of the sample was recruited using probability methods, though both methods are outlined in more detail below.

The study ultimately exceeded its sampling target of 1,100 households, collecting data from a total of 1,120 households across the two sampling methods.

3.1 ABS SAMPLING METHODS AND EVALUATION

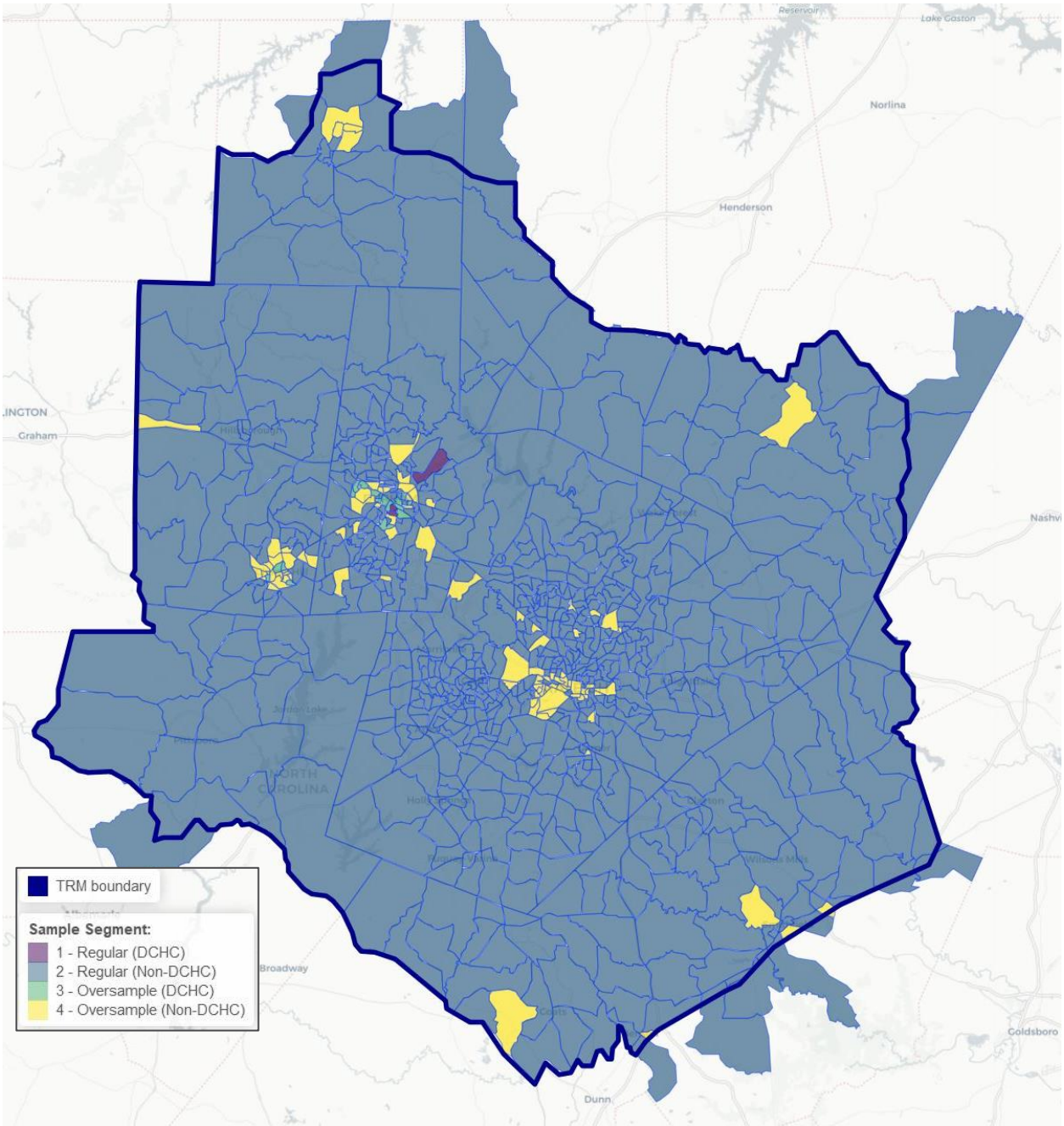
Sample Frame and Sample Area

The sampling frame for this survey was the list of all households in block groups that overlap the TRM region. RSG used address-based sampling to select households for participation. Address-based sampling involves drawing a random sample of addresses from all residential addresses in that area. Using this method, all households within each defined area had an equal chance of selection for the sample. RSG purchased household mailing addresses from Marketing Systems Group (MSG), which maintains the Computer Delivery Sequence file from the U.S. Postal Service.

[9] Probability sampling describes methods in which samples of a population are selected to be surveyed at random, while non-probability sampling describes methods in which samples are not selected randomly from the entire population.

Figure 1 depicts the TRM boundary and the block groups sampled, stratified by sampling segment.

FIGURE 1: SAMPLE AREA AND SAMPLING SEGMENT LOCATIONS



Sample Methods and Rates

The 2021 HTS aimed to collect complete data from 1,100 households. A representative sample was achieved through two primary oversampling methods in the probability sample, described below.

Targeted Oversampling

Targeted oversampling is designed to collect sufficient data from households that demonstrate harder-to-find (but important) travel behaviors and ensure enough representation in the final sample to model these behaviors. Aligned with the 2018 sample plan, the 2021 sample plan targeted households with no vehicles, households led by a young person under age 25, non-family households, and non-auto commuters.

To achieve this greater representation in the final data, RSG used 2014-2018 American Community Survey (ACS) data – the most recently available ACS data at the time of the sample plan – to identify block groups that have a high prevalence of the targeted household characteristics. Block groups were identified for oversampling if the concentration of the targeted households/individuals exceeded the 95th percentile across all block groups in the survey area. The 95th percentile is the threshold in which 95% of the block groups have a smaller percentage of this behavior[10]. Since there are 857 block groups in the region, and the threshold is the 95th percentile, the number of block group in each targeted sample group was 43. There were 115 block groups in total identified for this higher rate of sampling. RSG targeted these block groups at a rate three times the average sampling rate.

Compensatory Oversampling

Compensatory oversampling is designed to collect sufficient data from households that are known to respond to surveys at lower rates, regardless of their prevalence in a region. Aligned with the 2018 sample plan, the 2021 sample plan included compensatory oversampling for low income (less than $25,000 per year) and large (five or more member) households.

Like the targeted oversampling, RSG used 2014-2018 ACS data to identify the proportion of low income and large households in each block group. RSG then produced a model using the actual 2016 and 2018 response rates (both regular and oversampling) by block group to predict the 2021 response rates as a function of the proportion of low income and large households. RSG applied this model to all block groups in the survey region. Given historic decreases in Household Travel Survey response rates over time (and uncertainty about response rates due to COVID-19), RSG then further reduced the anticipated response rates from the model by

[10] For example, the 95th percentile for zero vehicle households in the region is 24%. This means 95% of the block groups have a percentage of zero vehicle households less than 24% while 5% of the block groups have a percentage of zero vehicle households higher than 24%.

15%. The resulting response estimates were used to determine the count of invitations sent to each sample segment.

DCHC Additional Sampling

In addition to the targeted and compensatory oversampling methods listed above, the study also included a separate sample with the goal of obtaining complete survey responses from 100 additional households in the DCHC-MPO area (the goal for the rest of the survey sample was complete survey samples from 1,000 households, for a total of 1,100). These samples were targeted in 20 block groups that the DCHC-MPO specified. This DCHC-MPO-specific sample segment supplemented the DCHC-MPO households that were included via regular sampling and oversampling methods, not in place of them. The DCHC-MPO-specific sample segment was also divided into Regular and Oversample segments like the rest of the survey sample.

COVID-19 Response Adjustments

RSG adjusted the originally planned invitations rates prior to data collection given anticipated lower response rates due to COVID-19. Given that the study's highest priority was to reach the 1,100 target, 9,600 additional invitations were added to the "Regular" and "Regular (DCHC)" sample segments to optimize response (given the expected higher response rates in those segments). The final ABS sample plan is summarized in Table 2 below.

TABLE 2: SAMPLE RATES AND PLANNED DATASET COMPOSITION

Sample Segment	Block Groups	2014–2018 ACS HHs	Invited HHs	Invitation Rate[11]	Target Complete HHs	Target Sample Rate[12]
1: Regular (DCHC)	3	1,243	460	37.0%	5	0.4%
2: Regular	739	631,960	27,340	4.3%	737	0.1%
3: Oversample (DCHC)	17	10,556	5,500	52.1%	133	1.3%
4: Oversample	98	64,077	6,700	10.5%	225	0.4%
Total	**857**	**707,836**	**40,000**	**5.7%**	**1,100**	**0.2%**

[11] Invitation Rate = Invited HHs ÷ ACS HHs
[12] Target Sample Rate = Target Complete HHs ÷ ACS HHs

ABS Sample Plan Evaluation

Despite significantly increasing the 2021 invitation rates compared to previous years, ABS response rates were much lower than anticipated, resulting in a slight shortfall of the original 1,100 target through this method alone. To account for this shortfall, the study team integrated non-probability sampling partway through the study to meet the survey target (described below). The final ABS sample rates are shown in Table 3.

TABLE 3: FINAL ABS SAMPLE RATES

Sample Segment	Invited HHs	Target Complete HHs	Sample HHs	% of Sample HHs	2014–2018 ACS HHs	Sample Rate[13]
1: Regular (DCHC)	460	5	8	0.9%	1,243	0.6%
2: Regular	27,340	737	621	66.0%	631,960	0.1%
3: Oversample (DCHC)	5,500	133	126	13.4%	10,556	1.2%
4: Oversample	6,700	225	186	19.8%	64,077	0.3%
Total	**40,000**	**1,100**	**941**	**100%**	**707,836**	**0.1%**

3.2 EMAIL SAMPLING METHODS AND EVALUATION

Given lower than expected recruitment rates during the first few weeks of the study, RSG and NCSU-ITRE integrated nonprobability email sampling to supplement the probability ABS sampling and reach the survey target. The study team re-invited 2018 HTS households that provided email addresses and agreed to be contacted in the future. In total, 1,010 households were invited by email. 179 of the households invited by email completed the full study, resulting in a total of 1,120 households across both sampling methods (exceeding the study target).

[13] Sample Rate = Sample HHs ÷ ACS HHs

4.0 SURVEY BRANDING, MATERIALS, AND COMMUNICATION

4.1 STUDY BRANDING

The study branding (i.e., study name, color scheme, and font selections) was developed by RSG in 2016 with input from NCSU-ITRE and was approved by the TAC. The same branding was used in the 2018 and 2021 studies to support continuity across data collection years. The project logo is shown below in Figure 2.

FIGURE 2: TRIANGLE TRAVEL SURVEY BRANDING

4.2 PRINT MATERIALS

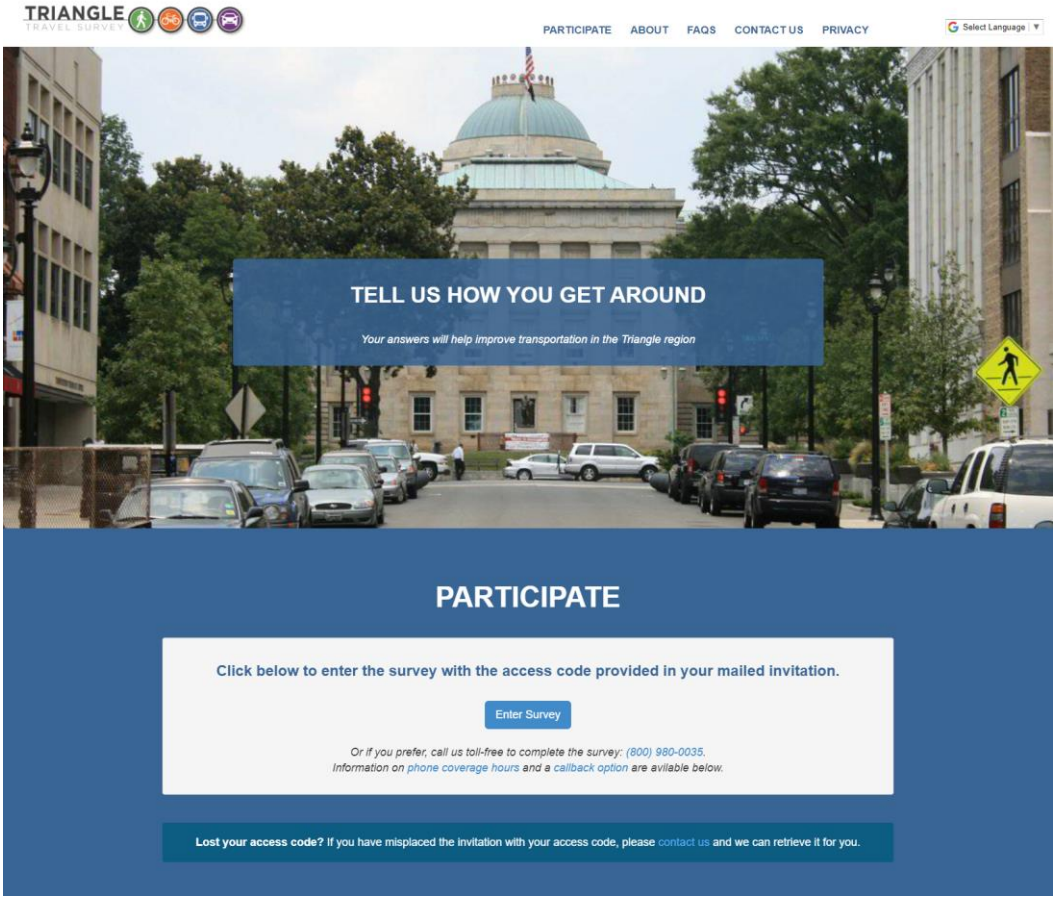
Each ABS household invited to participate in the 2021 HTS received three mailings:

- **Prenotice Postcard**: A prenotice postcard notified invited households that they would receive a formal invitation to participate in the study and offered an incentive after completing the study. Households were invited to log onto the website with a household-specific code printed on the postcard or call a toll-free number to learn more about the study and recruit into the survey.
- **Formal Invitation**: A formal invitation to the survey arrived shortly after the prenotice postcard. The cover letter (branded with the HTS banner letterhead) explained the study purpose, described the steps necessary to complete the study, repeated the household-specific code, and included logos and signatures from the sponsor agencies. The invitation also included a travel log and frequently asked questions sheet.
- **Reminder Postcard**: A reminder postcard arrived after the formal letter to encourage every household to complete the travel diary. Similar to the prenotice postcard, the reminder included the study phone number, website address, and participant login information.

4.3 PROJECT WEBSITE

In 2021, the study website was updated to reflect the addition of smartphone-app participation and streamline the design. All website sections were featured on a single page so key information was more easily accessible. The “TriangleTravelSurvey.com” domain name was purchased by RSG for the 2016 project and maintained for the 2018 and 2021 studies. The top portion of the website homepage is shown below in Figure 3.

FIGURE 3: TRIANGLE TRAVEL SURVEY WEBSITE



4.4 PARTICIPANT REMINDERS

Respondents were asked to provide an email address in the recruit survey. Reminder emails were sent throughout the travel period for smartphone-app respondents, and on and after the assigned travel day for online respondents. The emails were branded with the Triangle Travel Survey logo and maintained a consistent design.

5.0 DATA QUALITY CONTROL AND PREPARATION

The study team placed high importance on transparency in design, data preparation, scripting, and quality control throughout the 2021 HTS to ensure high-quality data and consistency across survey waves. RSG adhered to QA/QC measures throughout the project, including the review of key deliverables provided to NCSU-ITRE and the survey sponsors.

5.1 QUALITY CONTROL AND REVIEW

Survey Instrument Design

Following survey completion, RSG integrated data from both participation methods (smartphone and online/telephone) into a single dataset. To ensure seamless integration, the online and smartphone questionnaires were aligned as closely as possible during the design and programming phase.

RSG applied a combination of human-driven and automated tool-driven testing and validation to both survey instruments before collecting participant data. This testing helped ensure that question and answer logic worked as intended, question and answer choices were identified and labeled correctly, and that all data was captured in the desired way (e.g., home location geocoders worked as desired, no data fields were missing).

Both survey instruments also had built-in validation to ensure high-quality data. In rMove, these features included advanced programming to ensure that trips were correctly identified, minimizing both false-positive and false-negatives (e.g., confirming movement with accelerometer to reduce false-positives from tower switching). In the online survey, these features include logic checks on trip lengths and geocoded origins and destinations. Both instruments also employed skip logic to minimize respondent burden and validate responses. Implementing rigorous survey instrument testing and design protocols ensured that the final dataset meets quality standards.

Study Branding, Communication, and Administration

RSG, NCSU-ITRE and the survey sponsors collaboratively developed a study brand to create a user-friendly experience and ensure consistency across survey materials, including mailed invitations, the study website, e-mails to participants, call center scripts, and outreach efforts. These materials aligned with branding used in 2016 and 2018 but leveraged latest best practices in communications and design.

When possible, RSG automated daily survey administration tasks – including e-mail reminders and call center reminder lists – to ensure quality and consistency in the survey experience.

Data Collection Monitoring

RSG provided NCSU-ITRE with a live web-based dashboard of survey results throughout the data collection period. This allowed the survey team to identify problems and make critical adjustments or updates as needed.

RSG Data Review and Quality Controls

RSG conducted a combination of human-driven and automated tool-driven data cleaning processes once data collection concluded. For example, smartphone trip path data was overlaid onto maps to ensure the trip segments, paths, and times were all correct. RSG has developed proprietary machine learning algorithms to assist in this process, helping to identify the trips most likely to require splitting into two trips (e.g., passenger drop-offs with a short stop period), merging with adjacent trips (e.g., trip split at long light in traffic), cleaning (e.g., spurious location jumps from urban canyon effect), or dropping from the dataset (e.g., spurious trips resulting from movement in a building). Analysts carefully reviewed many of the actions recommended by RSG's algorithms to add a secondary level of quality control to the process.

RSG also outlined all data processing steps in the dataset user's guide, provided alongside the final dataset.

5.2 DATASET PREPARATION

During and after data collection, responses were cleaned to assure the quality of the final data. Readers can view the dataset user's guide (appended) to learn more about the 2021 HTS data cleaning processes.

Integrating Data from Multiple Retrieval Modes

The study used three modes of travel data collection (online, call center, and smartphone). Following data collection, RSG integrated data from these modes into a single dataset.[14] Given close programming alignment between the instruments, all data was collected in a single database, removing the need for RSG to recode or combine variables during data processing and preparation.

[14] In 2016, the smartphone survey was delivered as a separate dataset from the web survey (online and call center). In 2021, the data were delivered as a single dataset regardless of participation mode.

Inclusion Criteria

Of the 41,010 households invited to participate in the 2021 study, 1,120 completed both the recruit survey and travel diary reporting portions of the study and reported home locations within the TRM study area. A household was considered complete when it met the following two conditions:

1. The household completed the recruit survey by answering all questions.
2. All participating household members provided complete travel diary information on at least one concurrent weekday (Monday – Thursday) during their travel period.

6.0 EXPANSION AND WEIGHTING

While the study's sampling methods aimed to collect a roughly representative fraction of the population in the unweighted sample, data expansion and weighting is always still necessary to ensure that the resulting datasets represent the entire population. The sample plan (which informs survey invitation strategies) addresses some of the population inconsistencies upfront, as do adjustments while the survey is in the field. The post-data-collection expansion and weighting processes address any remaining inconsistencies.

The weighting process compares selected demographics in the survey to external control data, then adjusts the survey dataset to improve its representativeness. Readers may review the appended weighting memo for full details on the 2021 HTS expansion and weighting process.

7.0 SURVEY RESULTS

The final survey dataset comprises six different "levels" of data:

- Household-level data.
- Person-level data.
- Vehicle-level data.
- Trip-level data.
- Day-level data.
- Location-level data.[15]

This section of the report summarizes survey responses at household-, person-, and trip-level, presenting unexpanded/unweighted ("Sample") and expanded/weighted ("2021 Expanded")[16] survey results side-by-side. Some tables also include corresponding PUMS data (1-year, 2019, the most recent available). The 2019 PUMS data were also used in creating the expansion targets, as described in the weighting memo. Note that the expanded counts may vary slightly between tables due to rounding.

Table 4 summarizes the unweighted samples and expanded counts across key dimensions. Note that all trip rates throughout this section are calculated by taking the average of trips taken on weekdays (Mondays – Thursdays) on which the entire household is complete.

TABLE 4: 2021 HTS RESULTS SUMMARY

Metric	Sample	2021 Expanded
Households	1,120	754,833
Mean HH Size	2.04	2.42
Persons	2,282[17]	1,783,517
Vehicles	1,900	1,420,122
Mean Vehicles per HH	1.70	1.88
Trips	22,660	4,493,619
HH Trip Rate	5.44	5.95
Person Trip Rate	2.91	2.52

[15] Location dataset was provided only to NCSU-ITRE as all data it contains is considered personally identifiable information (PII).
[16] The expanded/weighted values in this report are based on a weighting process that only incorporates 2021 survey data; in the final data deliverable, RSG also provided a set of household and trip weights based on the combined set of 2016, 2018, and 2021 HTS responses.
[17] 2,282 is the total count of records in the person-level table, including non-surveyable persons (persons in the household not related to person number 1). The number of surveyable persons (with valid person-weights) is 2,188.

Household travel survey data collected via rMove tend to exhibit different characteristics compared to those collected via online surveys. For example, trip rates tend to be higher among rMove participants because each trip is collected in real-time whereas trips reported in the online survey are recalled after the travel day. Table 5 shows the differences between rMove households and online households among select dimensions.

TABLE 5: 2021 HTS RESULTS, BY DATA COLLECTION METHOD

Metric	Total Sample	rMove HHs	Online/ Telephone HHs
Households	1,120	440	680
% of Sample HHs	100%	39.3%	60.7%
Trips	22,660	19,535	3,125
% of Sample Trips	100%	86.2%	13.8%
HH Trip Rate	5.44	5.81	4.60
Person Trip Rate	2.91	3.22	2.25

7.1 HOUSEHOLD-LEVEL DATA

Table 6 shows household (HH) counts by county in the study area. Note that the expanded households by county vary slightly from the census data by county because the block groups used for weighting were aggregated to regions larger than counties during expansion. Please see the weighting memo for additional details.

TABLE 6: 2021 HTS HOUSEHOLDS, BY COUNTY

County	Sample HHs	% of Sample HHs	2021 Expanded HHs	% of 2021 Expanded HHs	2019 HHs (PUMS)	% of 2019 HHs (PUMS)
Durham	299	26.7%	131,140	17.4%	131,140	17.3%
Orange	151	13.5%	58,098	7.7%	55,253	7.3%
Wake	563	50.3%	419,363	55.6%	419,363	55.6%
Chatham*	22	2.0%	21,102	2.8%	17,438	2.3%
Franklin*	18	1.6%	40,064	5.3%	24,498	3.2%
Granville*	3	0.3%	6,467	0.9%	13,758	1.8%
Harnett*	4	0.4%	4,035	0.5%	15,865	2.1%
Johnston*	51	4.6%	68,527	9.1%	62,157	8.2%
Nash*	0	0.0%	0	0.0%	2,819	0.4%
Person*	9	0.8%	6,037	0.8%	12,546	1.7%
Total	**1,120**	**100%**	**754,833**	**100%**	**754,837**	**100%**

** County partially overlaps model region. HHs outside the model region are not included in this table.*

Household size, income, and vehicle ownership typically impact travel behavior and are key weighting dimensions. Table 7 through Table 9 show survey results and PUMS estimates of households for these three variables. The observable differences between the survey results and the PUMS data are typical of household travel studies.

Compared to the general population, the survey sample has a smaller proportion of low-income and large households, as was the case in 2018. Low-income households are frequently underrepresented in household travel surveys and larger households can be difficult to recruit and retain due to the additional burden per respondent for the household overall. To ensure burden was not disproportionate for large households who participated via rMove, children's travel was only reported on a single travel day. The original sample plan included compensatory oversampling to improve the overall sample rate of households with incomes below $25,000 and large (five or more member) households. This compensatory oversampling could be improved in the future by targeting households based on estimated income from the sample provider. This approach generally targets low-income households more directly than geography-based targeting. The weighting process (also reflected in these tables) addresses these inconsistencies in the final dataset.

TABLE 7: HOUSEHOLD SIZE

HH Size	Sample HHs	% of Sample HHs	2021 Expanded HHs	% of 2021 Expanded HHs	2019 HHs (PUMS)	% of 2019 HHs (PUMS)
1 person	398	35.5%	208,320	27.6%	207,859	27.5%
2 people	467	41.7%	260,982	34.6%	260,538	34.5%
3 people	118	10.5%	122,599	16.2%	122,228	16.2%
4 people	102	9.1%	103,186	13.7%	102,893	13.6%
5+ people	35	3.1%	59,745	7.9%	61,318	8.1%
Total	**1,120**	**100%**	**754,832**	**100%**	**754,836**	**100%**

TABLE 8: HOUSEHOLD INCOME (REPORTED OR IMPUTED IF NOT REPORTED)

HH Income	Sample HHs	% of Sample HHs	2021 Expanded HHs	% of 2021 Expanded HHs	2019 HHs (PUMS)	% of 2019 HHs (PUMS)
Under $25,000	131	11.7%	111,641	14.8%	114,718	15.2%
$25,000–$49,999	218	19.5%	150,515	19.9%	150,823	20.0%
$50,000–$74,999	199	17.8%	133,333	17.7%	121,129	16.0%
$75,000–$99,999	154	13.8%	81,040	10.7%	97,781	13.0%
$100,000–$149,999	239	21.3%	131,137	17.4%	127,552	16.9%
$150,000+	179	16.0%	147,167	19.5%	142,833	18.9%
Total	**1,120**	**100%**	**754,833**	**100%**	**754,836**	**100%**

TABLE 9: VEHICLE OWNERSHIP

HH Vehicles	Sample HHs	% of Sample HHs	2021 Expanded HHs	% of 2021 Expanded HHs	2019 HHs (PUMS)	% of 2019 HHs (PUMS)
0 vehicles	43	3.8%	42,553	5.6%	42,551	5.6%
1 vehicle	449	40.1%	232,298	30.8%	232,297	30.8%
2 vehicles	482	43.0%	307,045	40.7%	307,043	40.7%
3+ vehicles	146	13.0%	172,937	22.9%	172,943	22.9%
Total	**1,120**	**100%**	**754,833**	**100%**	**754,836**	**100%**

7.2 PERSON-LEVEL DATA

Table 10 through Table 13 show person-level study results. Note that the weighting process for this study used household-level targets rather than person-level targets, so the sum of person-level weights (labeled "2021 Expanded Persons") does not perfectly match the 2019 PUMS estimate.

Persons aged 25–34 years old participated at higher rates than their share of the general population, while the sample contains a smaller share of children under 18 years old than the general population. By race, the most significant difference between sample participation rates and the general population is the underrepresentation of persons who are African American or Black.

TABLE 10: AGE DISTRIBUTION

Person Age	Sample Persons	% of Sample Persons	2021 Expanded Persons	% of 2021 Expanded Persons	2019 Persons (PUMS)	% of 2019 Persons (PUMS)
Under 18 years	371	16.3%	434,448	24.4%	450,608	24.5%
18–24 years	161	7.1%	88,630	5.0%	135,330	7.3%
25–34 years	494	21.6%	253,649	14.2%	257,549	14.0%
35–44 years	349	15.3%	277,021	15.5%	263,691	14.3%
45–54 years	291	12.8%	255,961	14.4%	257,552	14.0%
55–64 years	280	12.3%	211,604	11.9%	227,312	12.3%
65 years+	336	14.7%	262,204	14.7%	250,619	13.6%
Total	**2,282**	**100%**	**1,783,517**	**100%**	**1,842,661**	**100%**

TABLE 11: GENDER DISTRIBUTION

Person Gender	Sample Persons	% of Sample Persons	2021 Expanded Persons	% of 2021 Expanded Persons	2019 Persons (PUMS)	% of 2019 Persons (PUMS)
Female	1106	50.5%	882,929	49.5%	951,179	51.6%
Male	982	44.9%	819,050	45.9%	891,842	48.4%
Nonbinary	19	0.9%	12,842	0.7%	-	-
Other/prefer to self-describe	5	0.2%	3,603	0.2%	-	-
Prefer not to answer	76	3.5%	65,092	3.6%	-	-
Total	**2,188**[18]	**100%**	**1,783,517**	**100%**	**1,842,661**	**100%**

[18] The "gender" survey question was only asked of surveyable persons (i.e., persons who were related to person number 1)

TABLE 12: RACE DISTRIBUTION

Person Race	Sample Persons	% of Sample Persons	2021 Expanded Persons	% of 2021 Expanded Persons	2019 Persons (PUMS)	% of 2019 Persons (PUMS)
African American or Black	140	7.7%	119,425	8.9%	299,623	21.5%
American Indian or Alaska Native	5	0.3%	3,283	0.2%	6,276	0.5%
Asian	100	5.5%	75,701	5.6%	79,598	5.7%
Native Hawaiian or other Pacific Islander	1	0.1%	323	0.0%	688	0.0%
Other	22	1.2%	13,168	1.0%	45,660	3.3%
White	1,331	73.2%	946,434	70.2%	936,343	67.3%
Two or more races	51	2.8%	49,081	3.6%	23,865	1.7%
Prefer not to answer	168	9.2%	141,488	10.5%	-	-
Valid Total	**1,818**	**99.9%**	**1,348,903**	**99.9%**	**1,392,053**	**100%**
Missing: Non-Response	1	0.0%	167	0.0%	-	-
Total	**1,819**[19]	**100%**	**1,349,070**	**100%**	**1,392,053**	**100%**

TABLE 13: EMPLOYMENT STATUS

Person Employment Status	Sample Persons	% of Sample Persons	2021 Expanded Persons	% of 2021 Expanded Persons	2019 Persons (PUMS)	% of 2019 Persons (PUMS)
Employed full-time (paid)	1,012	52.0%	671,285	47.9%	861,654	59.7%
Employed part-time (paid)	184	9.5%	145,058	10.4%	-	-
Self-employed	118	6.1%	113,132	8.1%	85,700	5.9%
Work-for-pay Total	**1,314**	**67.6%**	**929,475**	**66.4%**	**947,354**	**65.6%**
Not employed and not looking for work (e.g., retired, stay-at-home parent, student)	530	27.2%	404,407	28.9%	445,497	30.9%
Unemployed and looking for work	63	3.2%	47,379	3.4%	36,281	2.5%
Unpaid volunteer or intern	21	1.1%	7,315	0.5%	-	-
Employed, but not currently working (e.g., on leave, furloughed 100%)	18	0.9%	12,560	0.9%	14,043	1.0%
Total	**1,946**[20]	**100%**	**1,401,136**	**100%**	**1,443,175**	**100%**

[19] The “race” survey question was only asked of surveyable adults (i.e., persons age 18+ who were related to person number 1)
[20] The “employment” survey question was only asked of surveyable persons of working age (i.e., persons age 16+ who were related to person number 1)

7.3 TRIP-LEVEL DATA

Overall trip rates were calculated by taking the average of trips taken on weekdays (Mondays – Thursdays) on which the entire household is "complete." Note that in the 2016 and 2018 surveys, all households provided a single day of travel. While households in the 2021 survey were only included in the final dataset if all members had completed all surveys on a single consecutive weekday, many households that participated via rMove completed more than one day (up to seven), and these additional data are included in the dataset. Therefore, to ensure trip rates only reflect trips on days where travel is known to be "complete," trip rates are calculated using complete household weekdays. Readers can refer to the dataset user's guide for more information on "complete" travel days. There are 12,351 trips included in the dataset on 4,249 complete household weekdays, while there are 22,660 total trips and 7,000 total days in the dataset.

Approximately 23.6% of complete person-days are days on which the person reported making no trips on that travel day; these person-days were included in average trip rate calculations, regardless. This high proportion of no-travel days may be attributable to reduced daily travel due to the COVID-19 pandemic.

Readers should interpret patterns in the following tables as correlative rather than causal. For example, travel differences among different ages or races may be tied to other factors like income, employment status, or home locations.

TABLE 14: TRIP RATES, BY HOUSEHOLD SIZE

HH Size	Trip Records	Raw Trip Rate (HH)	2021 Expanded Trips	2021 Expanded Trip Rate (HH)
1 person	2,961	3.33	641,262	3.08
2 people	5,342	5.99	1,413,230	5.42
3 people	1,451	6.31	789,447	6.44
4 people	1,920	9.37	900,025	8.72
5+ people	677	12.54	749,655	12.55
Total	**12,351**	**5.44**	**4,493,619**	**5.95**

TABLE 15: TRIP RATES, BY GENDER

Person Gender	Trip Records	Raw Trip Rate (Person)	2021 Expanded Trips	2021 Expanded Trip Rate (Person)
Female	6,492	3.03	2,343,000	2.65
Male	5,511	2.85	2,016,359	2.46
Nonbinary	142	3.64	32,991	2.57
Other/prefer to self-describe	41	3.73	13,373	3.71
Prefer not to answer	165	1.32	87,896	1.35
Total	**12,351**	**2.91**	**4,493,619**	**2.52**

TABLE 16: TRIP RATES, BY AGE

Person Age	Trip Records	Raw Trip Rate (Person)	2021 Expanded Trips	2021 Expanded Trip Rate (Person)
Under 18 years	1,136	1.56	606,719	1.40
18–24 years	870	3.58	234,621	2.65
25–34 years	3,532	3.42	833,678	3.29
35–44 years	2,200	3.16	830,103	3.00
45–54 years	1,601	3.15	738,626	2.89
55–64 years	1,580	3.15	571,740	2.70
65 years+	1,432	2.67	678,131	2.59
Total	**12,351**	**2.91**	**4,493,619**	**2.52**

TABLE 17: TRIP RATES, BY RACE

Person Race	Trip Records	Raw Trip Rate (Person)	2021 Expanded Trips	2021 Expanded Trip Rate (Person)
African American or Black	843	3.48	385,988	3.23
American Indian or Alaska Native	42	3.82	10,965	3.34
Asian	499	2.64	195,235	2.58
Native Hawaiian or other Pacific Islander	0	0.00	0	0.00
Other	156	3.47	41,974	3.19
White	8,678	3.27	2,862,920	3.02
Two or more races	331	3.09	107,777	2.20
Prefer not to answer	666	2.44	282,040	1.99
Total	**11,215**[21]	**3.19**	**3,886,900**	**2.88**

[21] The “race” survey question was only asked of surveyable adults (i.e., persons age 18+ who were related to person number 1)

TABLE 18: TRIP RATES, BY DRIVER LICENSURE

Person Licensure	Trip Records	Raw Trip Rate (Person)	2021 Expanded Trips	2021 Expanded Trip Rate (Person)
Has driver's license	10,909	3.21	3,702,730	2.87
Has learner's permit	83	1.63	65,299	2.24
Does not have license or permit	288	2.22	167,330	2.03
Total	**11,280**[22]	**3.15**	**3,935,359**	**2.81**

TABLE 19: TRIP RATES, BY EMPLOYMENT STATUS

Person Employment	Trip Records	Raw Trip Rate (Person)	2021 Expanded Trips	2021 Expanded Trip Rate (Person)
Worker (Paid: full-time, part-time, self-employed)	8,129	3.23	2,742,084	2.95
Not worker	3,151	2.95	1,193,275	2.53
Total	**11,280**[23]	**3.15**	**3,935,359**	**2.81**

TABLE 20: TRIP RATES, BY UNIVERSITY/COLLEGE STUDENT STATUS

Person University Student Status	Trip Records	Raw Trip Rate (Person)	2021 Expanded Trips	2021 Expanded Trip Rate (Person)
University student (2-year college, 4-year college, graduate or professional school)	1,533	3.76	318,396	3.30
Not university student	10,818	2.82	4,175,223	2.48
Total	**12,351**	**2.91**	**4,493,619**	**2.52**

[22] The "license" survey question was only asked of surveyable persons of driving age (that is, persons age 16+ and related to person number 1)
[23] The "employment" survey question was only asked of surveyable persons of working age (i.e., persons age 16+ who were related to person number 1)

TABLE 21: TRIPS, BY DESTINATION PURPOSE

Trip Purpose	Trip Records (N)	Trip Records (%)	2021 Expanded Trips (N)	2021 Expanded Trips (%)
Home	7,315	32.3%	1,487,954	33.1%
Work	978	4.3%	312,838	7.0%
Work-related	1,168	5.2%	206,262	4.6%
School	261	1.2%	129,469	2.9%
School-related	0	0.0%	0	0.0%
Escort	1,484	6.5%	431,353	9.6%
Shop	3,449	15.2%	688,206	15.3%
Meal	2,608	11.5%	400,208	8.9%
Social/recreation	3,765	16.6%	387,348	8.6%
Errand	254	1.1%	189,884	4.2%
Change mode	206	0.9%	47,672	1.1%
Spent the night at non-home location	20	0.1%	670	0.0%
Other	1,152	5.1%	211,756	4.7%
Total	**22,660**	**100%**	**4,493,619**	**100%**

TABLE 22: TRIPS, BY MODE TYPE

Trip Mode	Trip Records (N)	Trip Records (%)	2021 Expanded Trips (N)	2021 Expanded Trips (%)
Walk	3,978	17.8%	402,467	9.0%
Bicycle	208	0.9%	23,478	0.5%
Bike-share	0	0.0%	0	0.0%
Scooter-share	0	0.0%	0	0.0%
Taxi	1	0.0%	207	0.0%
Ride-hailing service	23	0.1%	7,854	0.2%
Personal vehicle	17,880	80.1%	4,000,793	89.0%
Carshare	0	0.0%	0	0.0%
School bus	15	0.1%	10,379	0.2%
Shuttle	34	0.2%	4,589	0.1%
Transit	49	0.2%	16,301	0.%
Long distance passenger mode	26	0.1%	4,081	0.1%
Other	100	0.4%	23,470	0.5%
Total	**22,314***	**100%**	**4,493,619**	**100%**

** This table only includes trips for which mode was reported.*

7.4 GEOGRAPHIC COVERAGE

The maps in this section show the geographic extent of home, work, and school locations reported by survey respondents. These locations have been plotted with extra noise to ensure anonymity. Most plotted locations are within ~0.3 miles of the true locations.

For illustrative purposes, these maps exclude reported work and school locations outside the study region and its immediate surroundings.

FIGURE 4: PRIMARY HOME LOCATIONS (NOISE ADDED)

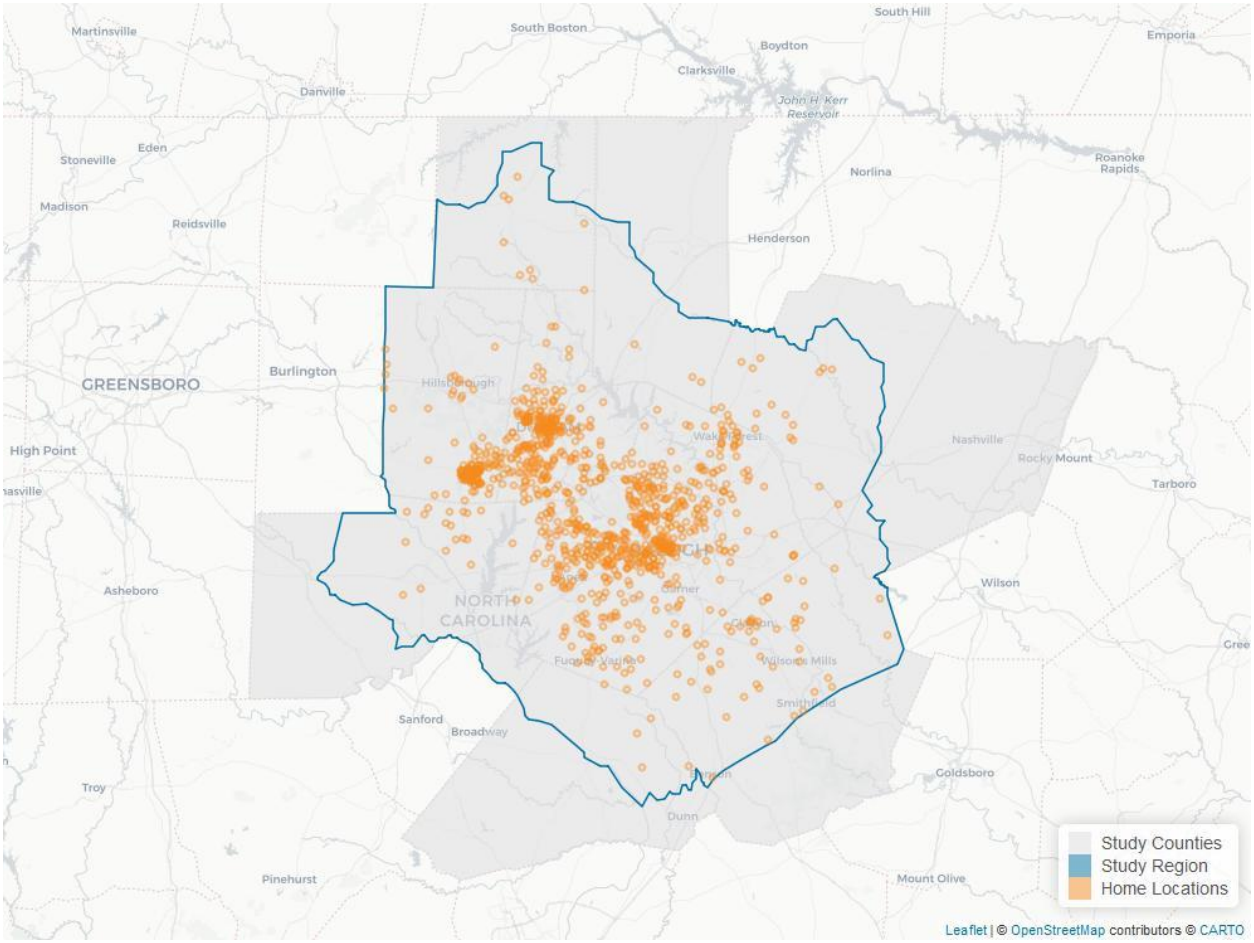


FIGURE 5: REPORTED PRIMARY WORK LOCATIONS (NOISE ADDED)

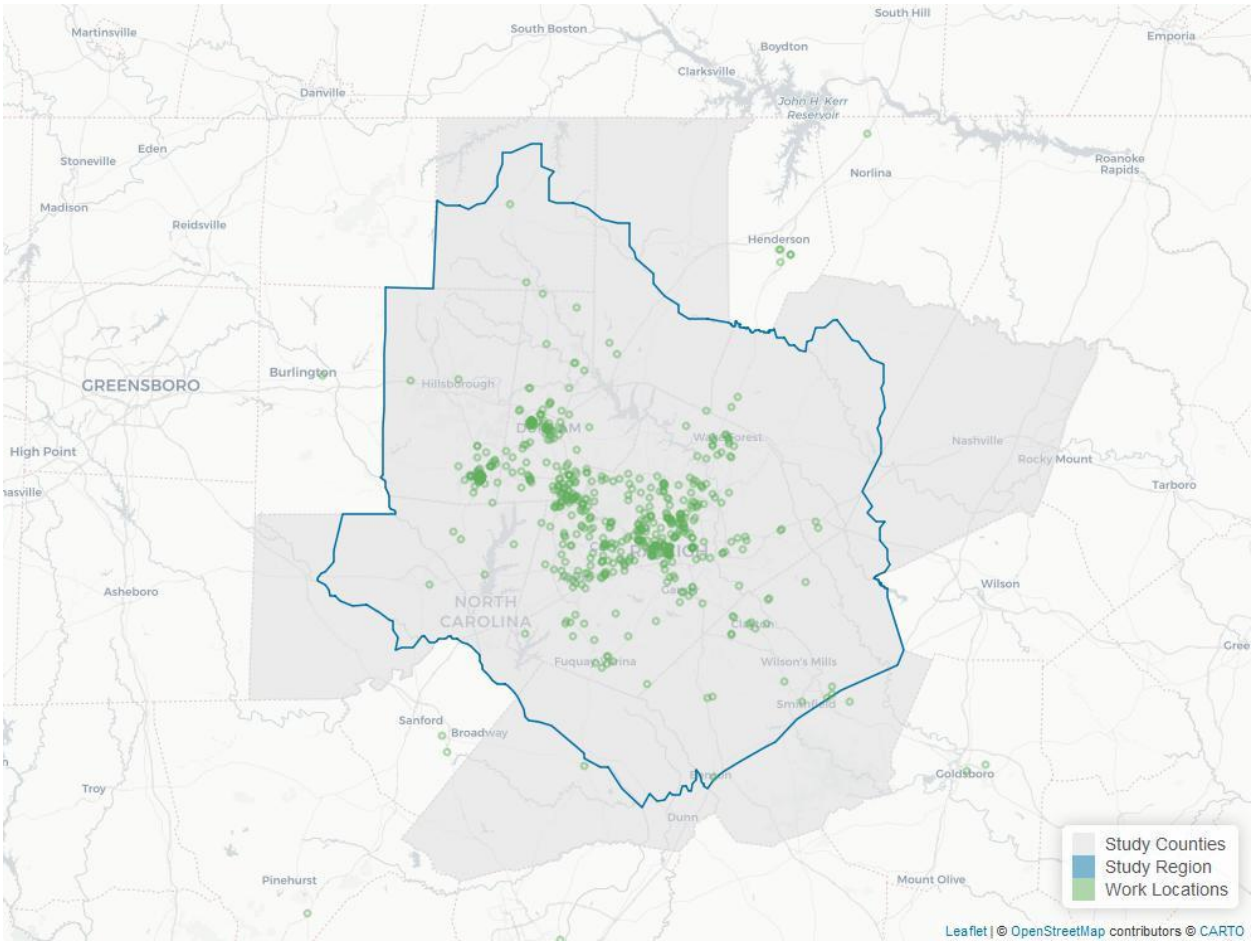
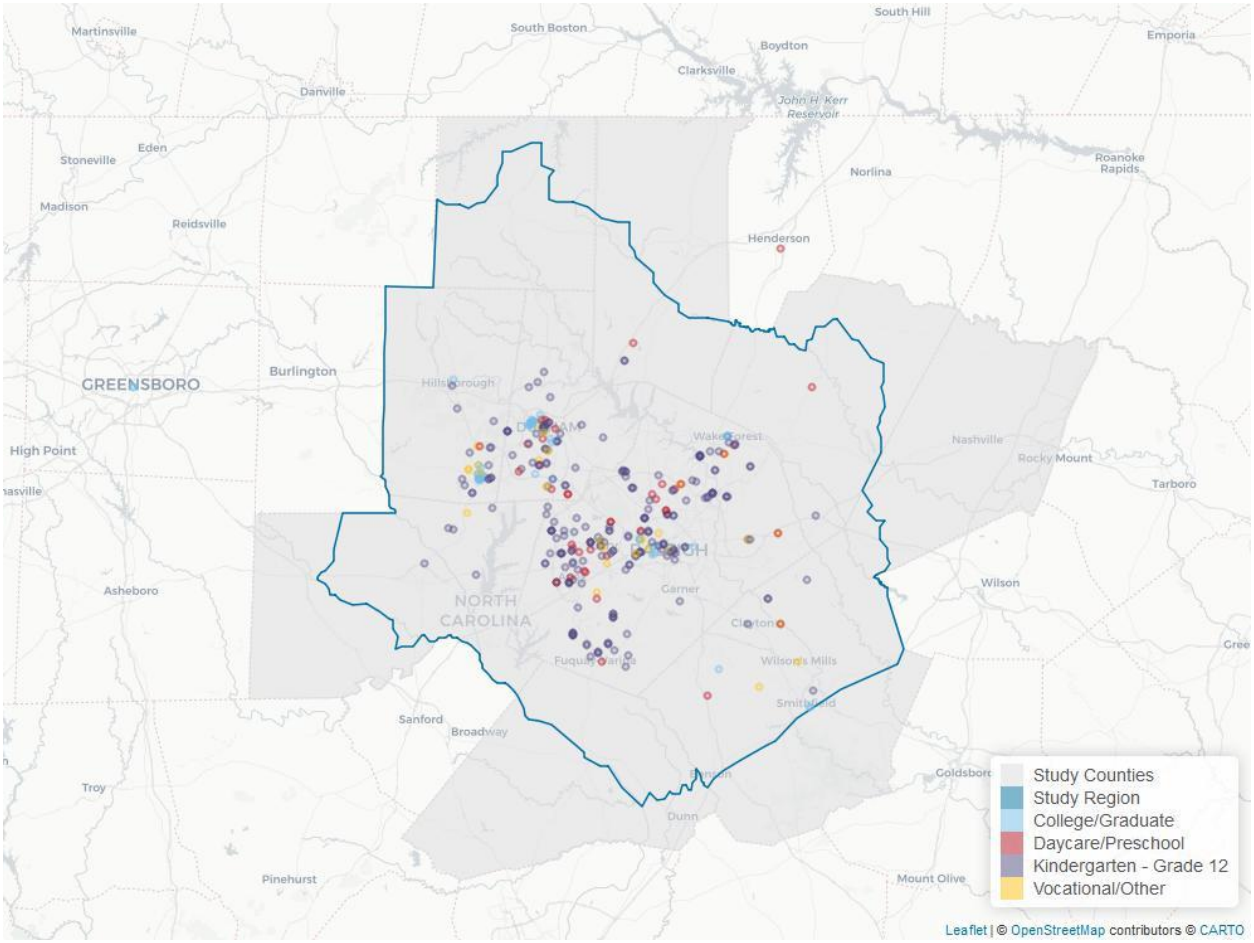


FIGURE 6: REPORTED SCHOOL LOCATIONS BY SCHOOL TYPE (NOISE ADDED)



8.0 SUMMARY

The 2021 Triangle Travel Survey collected current information about household and individual travel patterns for residents throughout the 10-county greater Triangle region. The study was conducted using the most current household travel survey methods for survey design, sampling, questionnaire design, data collection (including smartphone data collection), and data weighting, while maintaining consistency with the 2016 and 2018 surveys. A total of 1,120 households completed the 2021 survey, exceeding the survey target of 1,100 households. These households provided data critical for updating and developing the Triangle Regional Model.

9.0 APPENDICES

9.1 QUESTIONNAIRE

9.2 PRINT MATERIALS

9.3 DATA CODEBOOK

9.4 DATA USER GUIDE

9.5 TABULATIONS

9.6 WEIGHTING MEMO

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