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**NORTH CAROLINA STATE UNIVERSITY
INSTITUTE FOR TRANSPORTATION
RESEARCH AND EDUCATION**

2018 TRIANGLE REGION HOUSEHOLD TRAVEL SURVEY

Final Report | May 21, 2019

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LIST OF ABBREVIATIONS

ACS	AMERICAN COMMUNITY SURVEY
CAMPO	CAPITAL AREA METROPOLITAN PLANNING ORGANIZATION
CDS	COMPUTER DELIVERY SEQUENCE
DCHC-MPO	DURHAM-CHAPEL HILL-CARRBORO METROPOLITAN PLANNING ORGANIZATION
FAQ	FREQUENTLY ASKED QUESTIONS
FIPS	FEDERAL INFORMATION PROCESSING STANDARD
HH	HOUSEHOLD
HTS	HOUSEHOLD TRAVEL SURVEY
ITRE	INSTITUTE FOR TRANSPORTATION RESEARCH AND EDUCATION
NCDOT	NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
PUMA	PUBLIC USE MICRODATA AREA
RSG	RESOURCE SYSTEMS GROUP
TAC	TECHNICAL ADVISORY COMMITTEE
TAZ	TRAFFIC ANALYSIS ZONE
TRM	TRIANGLE REGIONAL MODEL
USPS	UNITED STATES POSTAL SERVICE



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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

1.1 STUDY OVERVIEW

The North Carolina State University Institute for Transportation Research and Education (NCSU-ITRE) and RSG conducted the 2018 Triangle Region Recurrent Household Travel Survey (2018 RHTS), branded as the 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 Triangle Region Household Travel Survey (2016 HTS), as referenced throughout this report. The primary difference is that, starting with the 2018 survey, household travel surveys in the Triangle region are planned to be conducted every two years, as opposed to the previous cycle of once every ten years, with a smaller number of households sampled in each survey effort, which, over the course of ten years, will add up to more households than were sampled in 2016 (which is why the 2018 survey is called a “recurrent” household travel survey).

A total of 1,498 households (HHs) in 10 counties 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 2018 RHTS. Wilkins Research, the study call center, assisted as a subconsultant to RSG.

Study Area

As in the 2016 HTS, the 2018 RHTS region includes all of Durham, Orange, and Wake counties and portions of Chatham, Harnett, Johnston, Franklin, Granville, Nash, and Person counties. The Triangle region is home to approximately 1.85 million residents.¹

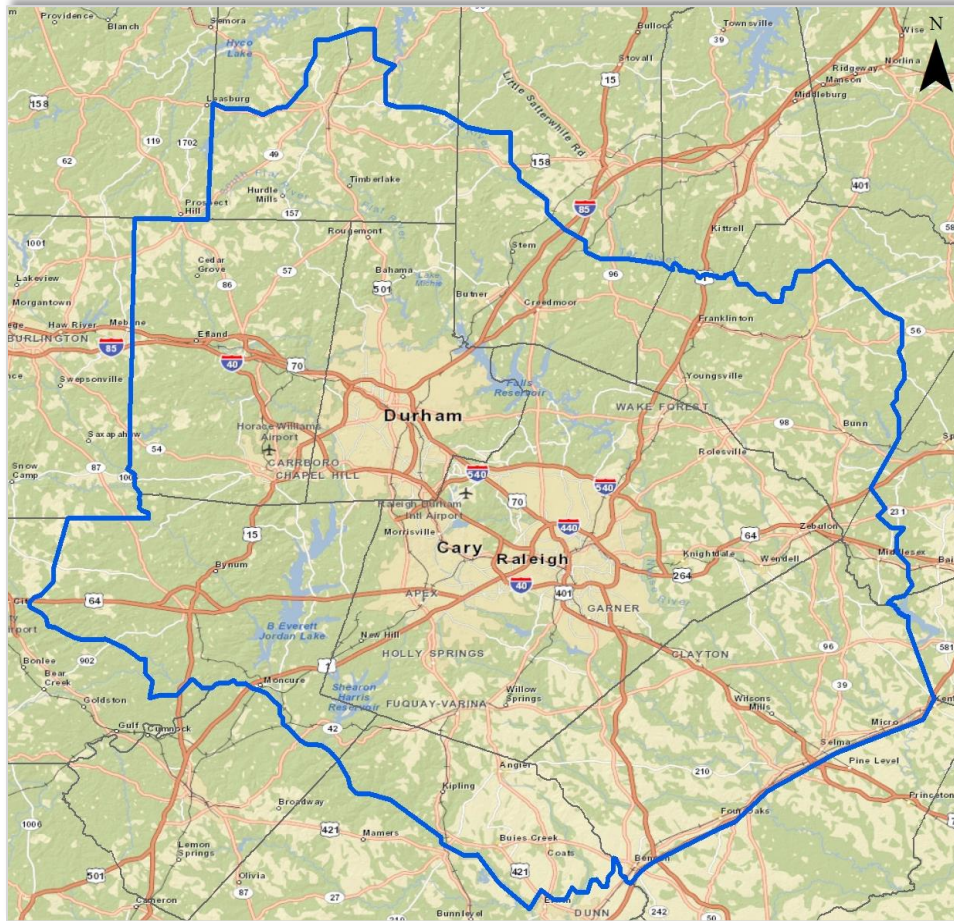
The region has a diverse economy, including many major employers in government, education, and private industry. In addition to being home to Research Triangle Park, the Triangle region is also home to two major medical centers, one housed at Duke University in Durham and the other at the University of North Carolina, Chapel Hill. The region includes four major universities and several smaller colleges and universities with approximately 108,000 students.²

Readers can reference the 2016 HTS report for further details about the study region.

¹ Based on ACS 2017 5-year estimates for table B1001, which includes the total population.

² Based on 2019 figures from Work In The Triangle: <http://www.workinthetriangle.com/learn/colleges-universities>

FIGURE 1: STUDY AREA



Study Objectives

The primary objective for the 2018 RHTS was to collect complete travel information for a 24-hour weekday period from a representative sample of at least 1,100 households in the Triangle region. The study also sought to collect a sufficient sample of households that—while more difficult to reach—are important to transportation policies and plans. These included low-income households, zero-vehicle households, non-family and young households, and households with non-auto commuters.

The 2018 RHTS provides current data about regional travel patterns to update and enhance the TRM. This data provides planners with the information necessary to help regional stakeholders and other local agencies understand current transportation behaviors to make informed planning and policy decisions.

The study effort combined multiple, proven methods of data collection, including:

- An address-based recruitment strategy with multiple first-class mailings.
- A data collection strategy that included telephone retrieval and web-survey technology.
- A public-facing project website and consistent branding throughout the survey.

The primary objective of the study was to collect complete travel information for a 24-hour weekday period from a representative sample of households in the Triangle region.

Table 1 is an overview of the approach for the 2018 RHTS project.

TABLE 1: SURVEY ACTIVITIES AND DESCRIPTION MATRIX

ACTIVITY	DESCRIPTION
Sampling	<ul style="list-style-type: none"> • Address-based sample using United States Postal Service (USPS) Computer Delivery Sequence (CDS) file (ensures inclusion of non-landline households) • Oversampling of groups, as needed, by geographic location or demographics
Initial Recruitment	<ul style="list-style-type: none"> • First-class mail prenotice postcards, study invitation packets, and reminder postcards to all invited households • Targeted outbound calls to households with telephone matches
Mid-Study Reminders	<ul style="list-style-type: none"> • Emails to households that provided e-mail addresses. • Telephone call(s) to households that provided a phone number during the study (separate from telephone matches in the sample)
Questionnaire Content	<ul style="list-style-type: none"> • Household Information/Recruit Survey: household and individual demographics • Travel Diary: household-member travel and activity diaries
Participation (Online Survey)	<ul style="list-style-type: none"> • Project website includes helpful resources for the respondent, including: Frequently Asked Questions (FAQs), travel log, privacy policy, contact information, and public outreach content • Extensive real-time logic checking at the trip, individual, and household levels to ensure consistency of diary entries and the highest-quality data • User-friendly, engaging, and interactive tools/features such as Google Maps, household-member dashboard, and trips/locations/vehicles from other household members' responses being prepopulated/saved • 100% real-time geocoding using the Google Maps API
Participation (Telephone)	<ul style="list-style-type: none"> • Toll-free number for respondents to call in and participate by phone • Operators use identical survey instrument to the online survey
Data Collection	<ul style="list-style-type: none"> • Collect complete data from a minimum of 1,100 households region-wide during the data collection period • Incentives to help encourage participation
Data Weighting and Expansion	<ul style="list-style-type: none"> • Weight and expand data for application • Sample and weights included as part of deliverable
Data Delivery & Reporting	<ul style="list-style-type: none"> • Interim data deliverable agreed upon by NCSU-ITRE delivered prior to data weighting and expansion • A final project report and weighted households, persons, and trips delivered at the conclusion of the study

Study Timeline

Table 2 documents the tasks, deliverables, and schedule associated with the 2018 HTS.

TABLE 2: PROJECT TIMELINE, TASKS, AND DELIVERABLES

PROJECT TASKS AND DELIVERABLES	DATES
Task 1: Refine materials, survey instrument, and sampling	
Revised survey methods, materials, and procedures	March – September 2018
Created sample plan	
Delivered final survey questionnaires, instruments, materials	
Task 2: Conduct survey	
Ordered address-based sample and mailed survey invitations	October – November 2018
Trained call center staff and facilitated participant support	
Monitored data collection and provided regular updates	
Task 3: Data coding, weighting, and expansion factors	
Created interim (pre-weighting) deliverable for ITRE review	November 2018 – March 2019
Revised draft deliverable	
Weighted final dataset (2018 alone and combined 2016+2018)	
Task 4: Delivery of final dataset and report	
Delivered final weighted dataset (2018 alone and combined 2016+2018) and accompanying documentation	April – May 2019
Delivered final project report	

1.2 SURVEY OVERVIEW

The 2018 HTS collected data from October 16, 2018 through November 15, 2018. The survey goal was to collect data from at least 1,100 households in the 10-county greater Triangle region (1,000 households in main part of the sample plus 100 additional households that the DCHC-MPO asked to have sampled from twenty specific Census block groups in their area). 30,500 households in the study region received invitation letters. A total of 1,498 households completed the survey (including those in the additional sample requested by the DCHC-MPO). Table 3 summarizes participation by county, based on the sample home address locations. Only three counties (Durham, Orange, and Wake) are entirely included within the current 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 3: MAIN SURVEY PARTICIPATION SUMMARY

COUNTY	ACS ³ HHS	INVITED HHS	RECRUITED HHS	COMPLETED HHS	RECRUITED HHS COMPLETION RATE ⁴	RESPONSE RATE ⁵	SAMPLE RATE ⁶
Durham	120,936	9,111	655	420	64.12%	4.61%	0.35%
Orange	52,160	3,347	306	210	68.63%	6.27%	0.40%
Wake	381,971	13,628	1,117	705	63.12%	5.17%	0.18%
Chatham	19,333	580	50	34	68.00%	5.86%	0.18%
Franklin	21,524	664	37	22	59.46%	3.31%	0.10%
Granville	12,168	340	19	10	52.63%	2.94%	0.08%
Harnett	13,466	517	22	13	59.09%	2.51%	0.10%
Johnston	57,854	1,849	117	66	56.41%	3.57%	0.11%
Nash	1,433	37	1	0	0.00%	0.00%	0.00%
Person	16,643	427	24	18	75.00%	4.22%	0.11%
Total	697,488	30,500	2,348	1,498	63.80%	4.91%	0.21%

³ 2013-2017 American Community Survey 5-Year Estimates for the portion of each county that is in the study area

⁴ Recruited HHs Completion Rate = Completed HHs ÷ Recruited HHs

⁵ Response Rate = Completed HHs ÷ Invited HHs

⁶ Sample Rate = Completed HHs ÷ ACS HHs

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 information helps to explain variations in travel patterns and allows for data weighting, as described in Section 6.0 of this report.

The survey was developed in three phases, with input from NCSU-ITRE and the TAC during each phase.

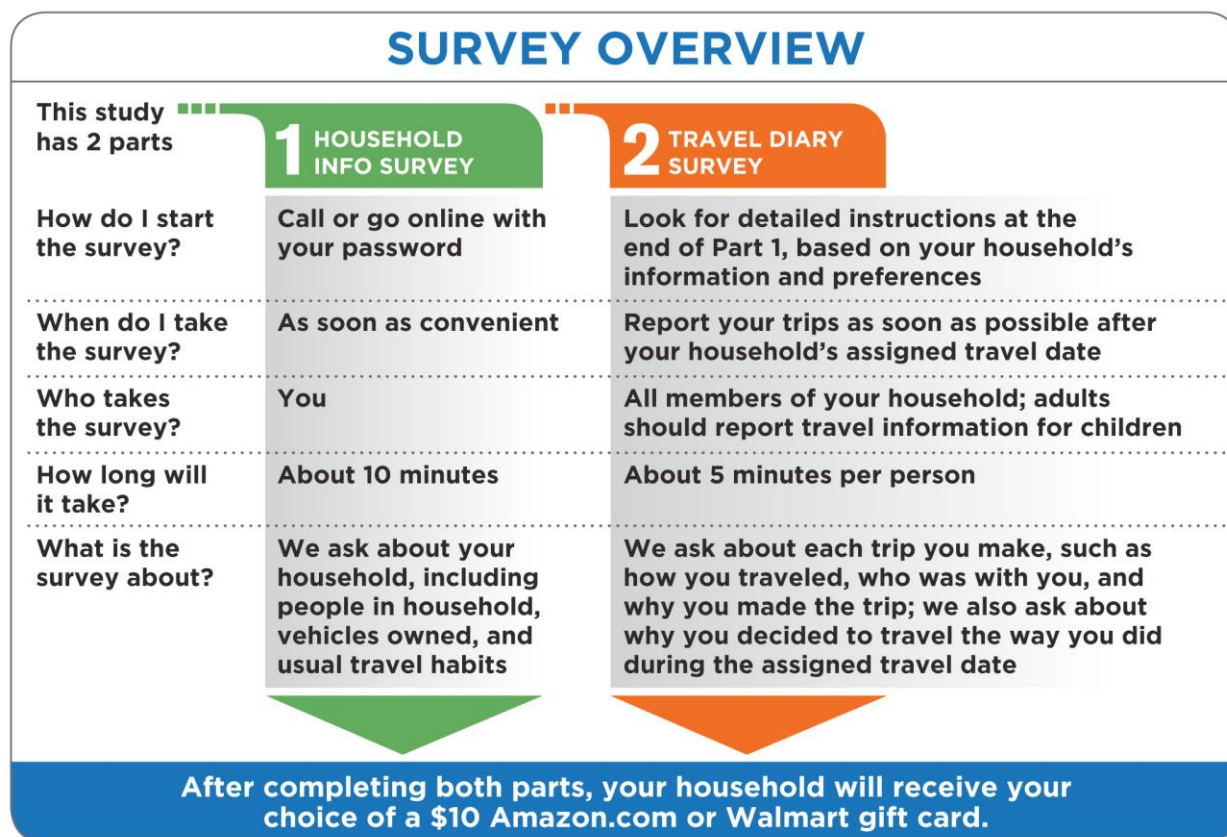
- **Phase One: Variable Identification:** RSG provided NCSU-ITRE with a suggested list of variables for the survey, based on the variables collected in the 2016 Triangle Travel Survey and RSG's household travel/activity survey experience. RSG and NCSU-ITRE reviewed and finalized this list, which the TAC subsequently approved. These variables were focused on core data elements required for transportation modeling and planning.
- **Phase Two: Survey Development:** RSG provided NCSU-ITRE with a questionnaire document that included all survey pages, questions, and response options for review. NCSU-ITRE provided input on question wording, preferred response options, question order, and questionnaire logic. Revisions were implemented accordingly and approved by NCSU-ITRE and the TAC. RSG then programmed the web-based survey instrument.
- **Phase Three: Survey Design and Implementation:** NCSU-ITRE and the TAC had the opportunity to preview and comment on the web-based survey instrument prior to study launch. Study respondents were also able to participate via telephone. Telephone operators who assisted respondents used the same web-based survey that web participants used. By administering the same survey both by phone and online, all responses were fully integrated with identical real-time validation.

The survey included two sections:

- **Part 1 (recruit survey):** This section collected all household-, person-, and vehicle-level information (e.g., number of household vehicles, 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 received further instructions to report their travel information after an assigned travel date.
- **Part 2 (travel diary):** This section collected all location-based trip-level and travel-day information (e.g., trip purpose and mode, telecommute time on travel day). All household members were required to complete a travel diary to complete the study. Household members were defined as anyone who lives in the same dwelling unit, including relatives, roommates, friends, or household help.

Figure 2, below, shows the study overview that was included in the study invitation, on the study website, and in the survey itself. *Please see the appended questionnaire file for full details about the survey content.*

FIGURE 2: STUDY OVERVIEW GRAPHIC



2.2 TRAVEL DATE ASSIGNMENT

The households invited to the one-day travel-diary survey were preassigned to a travel day of week (Tuesday – Thursday) to ensure even distribution of travel throughout the data collection period. Participants were not informed of their travel dates in the survey invitations. Instead, households were assigned to a travel date that matched their preassigned day of week after completing Part 1 (the “recruit” survey) online.

2.3 RECRUITMENT AND RETRIEVAL METHODS

All respondents were recruited by USPS mail. Households with landline phone numbers that did not respond to the recruitment mailings via the survey website were called and invited to participate. Wilkins Research was responsible for all telephone communications for the 2018 RHTS. Wilkins has highly-trained staff to conduct objective, professional telephone surveys while capturing respondents’ answers as fully as possible. RSG provided training documents,

including the questionnaire (screen by screen), for reference, and guidelines for what operators were to say, and outlined sections of the survey where respondents most frequently have questions (namely the geocoder and the trip-details page).

2.4 SURVEY INCENTIVES

A \$10 or \$20 gift card was offered to all households that completed the survey. The \$10 amount was printed on the invitation materials, but low-income (<\$25K/year) or large (5-or-more-member) households were offered a \$20 gift card upon completing Part 1 of the survey, provided that they also complete Part 2. Households could choose between Amazon or Walmart gift cards (sent via e-mail or USPS mail). Alternatively, households could opt not to receive any gift for participation. Table 4 shows the distribution of incentive types chosen by completed households. Most households preferred to receive their incentive via e-mail (76.4%). Amazon was the most popular incentive option, chosen by 65.8% of households.

TABLE 4. HOUSEHOLDS BY INCENTIVE TYPE

HOUSEHOLDS BY INCENTIVE TYPE	COMPLETE	PERCENT
Amazon (by e-mail)	986	65.8%
Walmart (by e-mail)	159	10.6%
Walmart (by mail)	336	22.4%
Neither	17	1.1%
Total	1,498	100.0%

SURVEY SAMPLING

The goal of the 2018 RHTS 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 data weighting and expansion) supported that goal by identifying key geographic-, demographic-, and travel-characteristic segments and determining sampling targets and response rates for these segments.

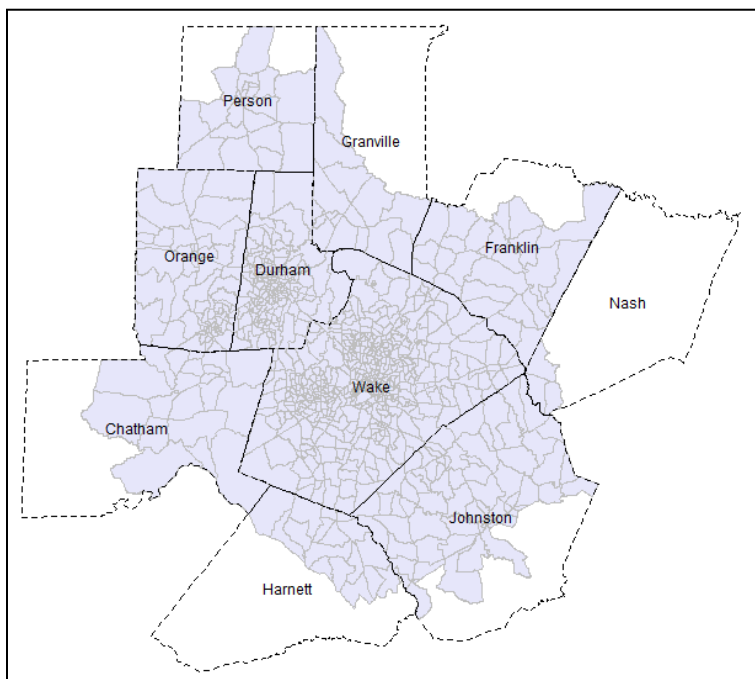
The sampling targets for certain segments were higher than those for the general population. This enabled sufficient data collection for households demonstrating certain behaviors (e.g., non-auto commuters) and ensured proper representation in the sample along various demographic factors relevant to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

3.1 SAMPLE FRAME AND SAMPLE AREA

The study used an address-based sampling approach, drawing a random sample from all of the households in the defined study area. With this method, all households in a given area have an equal chance of being selected. RSG purchased household mailing addresses from Marketing Systems Group (MSG) – a firm that maintains the U.S. Postal Service’s CDS file (an electronic database of all mailing addresses) – and sent survey invitation materials to these addresses.

RSG stratified the sample by Census block groups, which allowed for comparisons to selected demographic variables from the most recent ACS datasets available at the time (2012-2016), including household income, typical commute mode, vehicle ownership, and other important factors. Figure 3 depicts the 2018 RHTS study area and the associated block groups (included in purple).

FIGURE 3: SURVEY SAMPLE AREA BLOCK GROUPS BY COUNTY



3.2 SAMPLE METHODS AND RATES

The 2018 RHTS aimed to collect complete data from 1,100 households. This representative sample was achieved through two primary oversampling methods, described below.

Targeted Oversampling

Targeted oversampling aims to acquire complete responses from a specific population at a rate higher than proportional to the Census. An example would be an attempt to have 5% of the surveyed households have at least one transit rider in a region where only 2.5% of regional households have at least one transit rider. In this case, transit households are the segment targeted for oversampling.

To achieve this targeted oversampling, RSG used 2012-2016 ACS data to identify block groups with a high prevalence of key behaviors and attributes. Block groups that exceeded the 95th percentile among block groups in the study area for any of the targeted behaviors or attributes were included in the targeted oversample (e.g., in 95% of study-area block groups, less than 25% of households have no vehicle, so targeted oversampling is performed in block groups where more than 25% households have no vehicle). These behaviors and attributes were:

- Households with no vehicles;
- Households led by a person under the age of 25;
- Non-family households; and
- Non-auto commuters.

Compensatory Oversampling

Compensatory oversampling involves inviting a higher percentage of certain household types to more closely achieve Census proportional demographics prior to any weighting. This is useful when certain household types are known to respond at lower rates than others. Compensatory oversampling helps minimize differences between the study sample and the region's total population. Compensatory oversampling is distinct from targeted oversampling in that the categories of households that targeted oversampling attempts to reach are not necessarily ones with a known history of low response rates in travel surveys; instead, they are categories of households deemed important for modeling purposes, so it was decided to try to collect samples of them that are not too small to be statistically meaningful.

Among HTSs, it is well known that certain types of households are significantly less likely to respond to the survey instrument. To compensate for these lower expected response rates, the numbers of invitations sent to block groups were increased inversely proportionally to expected response rates. Similar to the targeted oversampling, RSG used 2012-2016 ACS data to identify block groups that met certain thresholds. The 2018 sampling plan included compensatory oversampling for:

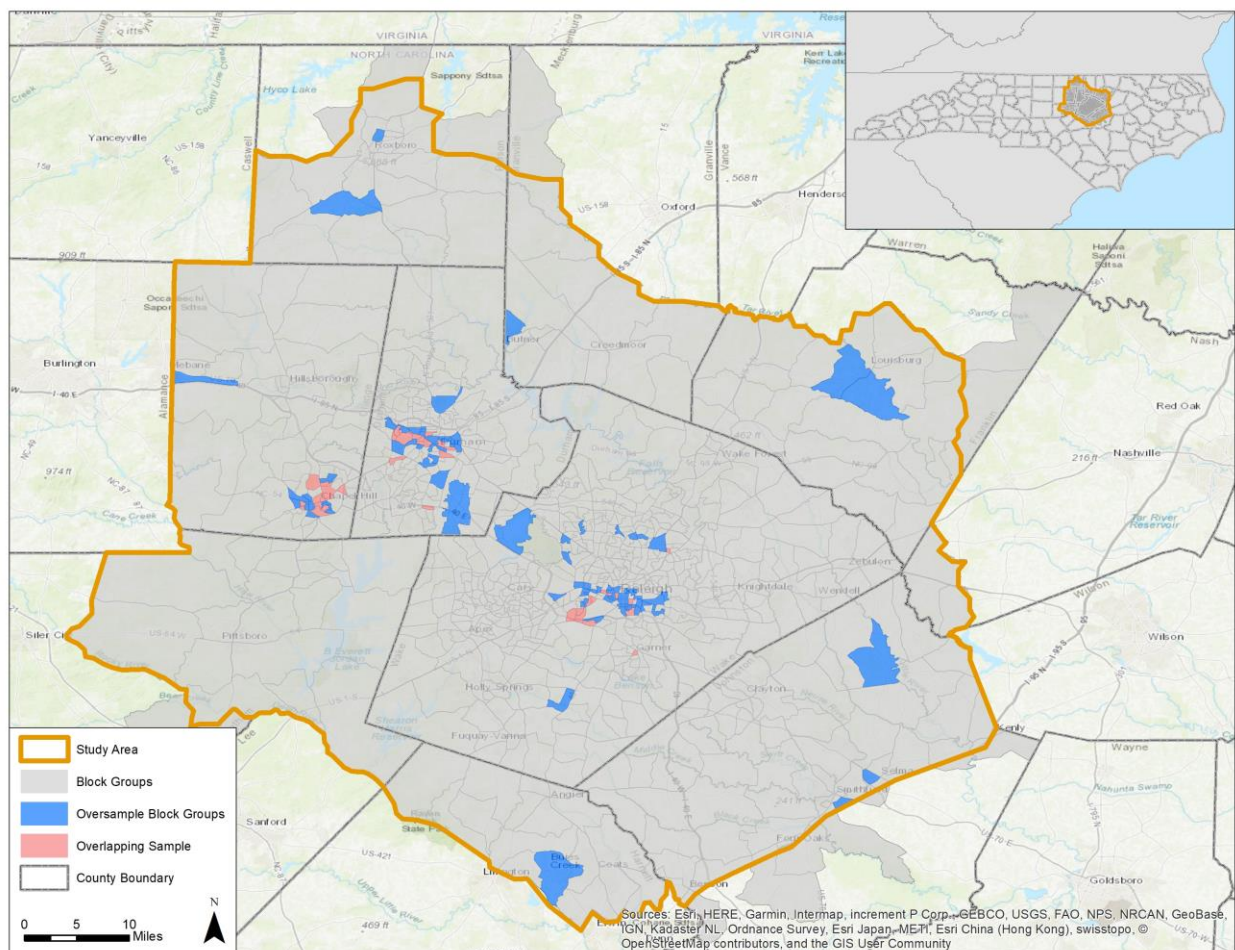
- Low-income (less than \$25,000 per year) households; and
- Large (5+-member) households.

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 was in addition to those DCHC-MPO households that were included via to regular sampling and oversampling methods, not in place of them. The DCHC-MPO-specific sample segment was also divided into Regular and Oversample segments, the same as the rest of the survey sample.

Figure 4 shows the block groups that were included in the targeted and compensatory oversamples. The block groups in blue qualified for oversampling based on only one of the two oversample criteria. The block groups in pink qualified for oversampling based on both of the oversample criteria.

FIGURE 4: OVERSAMPLE BLOCK GROUPS



The final sample plan is summarized in Table 5 below.

TABLE 5: TARGET SAMPLE SIZES AND RATES

SAMPLING SEGMENT	BLOCK GROUPS	2012-2016 ACS HHs	TARGET COMPLETES	EXPECTED RESPONSE RATE	INVITATIONS	INVITATION RATE
Regular sample (DCHC)	3	1,086	5	2.2%	500	46.0%
Regular sample (Non-DCHC)	735	607,865	743	4.3%	18,000	3.0%
Oversample (DCHC)	17	10,467	135	2.6%	5,500	52.5%
Oversample (Non-DCHC)	102	59,362	218	3.6%	6,500	10.9%
Total	857	678,780	1,100	3.9%	30,500	4.5%

Note: Invitation Rate = Invitations (sent) ÷ 2012-2016 ACS HHs

3.3 SAMPLE PLAN EVALUATION

The sample plan was effective overall in achieving both its total and segment-specific targets. The final sample sizes and rates are shown below.

TABLE 6: FINAL SAMPLE SIZES AND RATES

SAMPLE TYPE	INVITES	TARGET HHs	SAMPLE HHS	% OF SAMPLE HHs	2012-2016 ACS HHs	SAMPLE RATE (%)
Regular sample (DCHC)	500	5	16	1.1%	1,086	1.5%
Regular sample (Non-DCHC)	18,000	743	965	64.4%	607,865	0.2%
Oversample (DCHC)	5,500	135	224	15.0%	10,467	2.1%
Oversample (Non-DCHC)	6,500	218	293	19.6%	59,362	0.5%
Total	30,500	1,100	1,498	100.0%	678,780	0.2%

Note: Sample rate = Sample HHs ÷ 2012-2016 ACS HHs

4.0 SURVEY BRANDING, MATERIALS, AND COMMUNICATION

4.1 PROGRAM BRANDING

The 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 study to support continuity across data collection years. The project logo is shown below in Figure 5.

FIGURE 5: TRIANGLE TRAVEL SURVEY BRANDING



4.2 PRINT MATERIALS

Each of the households invited to participate in the 2018 RHTS 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 begin.

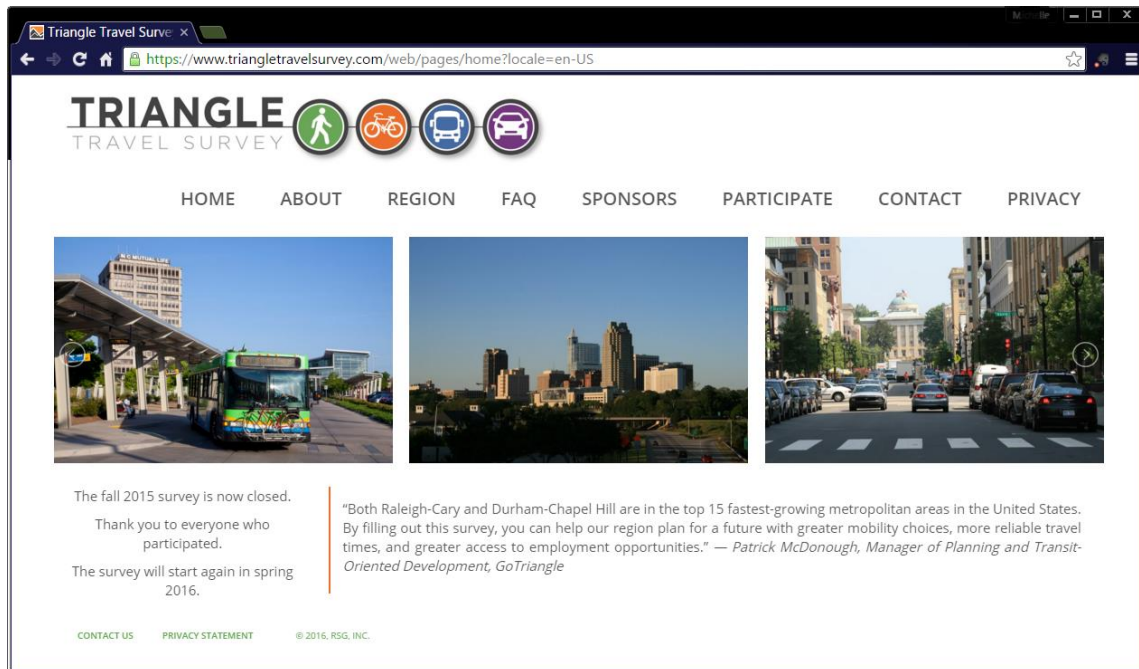
Formal Invitation: A formal invitation to the survey arrived shortly after the prenotice postcard. The cover letter (branded with the HTS banner letterhead) explained the study purpose, described the steps necessary to complete the study, repeated the household-specific code, and included logos and signatures from the sponsor agencies. The invitation also included a travel log and FAQ 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

For 2018, RSG updated the 2016 study website, which provides general information about the project. The website served as the portal to the household questionnaire and the travel diary survey. The "TriangleTravelSurvey.com" domain name was purchased by RSG for the 2016 project and maintained for the 2018 study. The website homepage is shown below, in Figure 6.

FIGURE 6: TRIANGLE TRAVEL SURVEY HOME PAGE



4.4 PARTICIPANT REMINDERS

As part of the household questionnaire (Part 1 of the survey), respondents were asked to provide their preferred means of contact (by telephone or e-mail). Those who preferred telephone contact were reminded the day before their travel date to keep track of their trips and were called after their travel date and reminded to complete the travel diary.

For the households that preferred e-mail contact, reminders and follow-up efforts were conducted by e-mail instead of by telephone. These efforts included:

- **Don't-Forget E-mail:** The day before the assigned travel date, a reminder e-mail was sent to all households who had provided an e-mail address.
- **Follow-up E-mail #1:** First thing on the morning after the assigned travel date, a reminder e-mail was sent to all households who provided an e-mail address and not all of whose members had yet submitted their travel-diary survey responses.
- **Follow-up E-mail #2:** This reminder e-mail was sent 48 hours after the assigned travel date and again on two subsequent occasions if complete travel-diary survey responses had not yet been submitted by all household members.

All reminder emails provided general information about the project and the incentives available upon completion of the study. Additionally, the emails included an e-mail address for participants to contact with any questions or comments about the project. RSG responded to emails sent from participating households within one business day.

4.5 RESPONDENT EXPERIENCE

The tables in this section provide details about the respondent survey experience, specifically the number of minutes to recruit into the survey and to provide trip details, by household size.

Note: The retrieval interview (Part 2) is person-based, which means not all household members are required to complete their diaries at the same time or using the same mode. Some households mixed call center and web completion. Table 8, therefore, shows the median length of time to complete the retrieval interview of the set of travel diaries completed through a given mode (call center or web) by people who happened to belong to a household of a given size (as opposed to the median duration for the set of households containing members who used a given mode).

TABLE 7: RECRUITMENT INTERVIEW LENGTH BY HOUSEHOLD SIZE (WEB AND CALL CENTER)

Household size	WEB		CALL CENTER		COMBINED	
	Recruit survey duration (minutes)		Recruit survey duration (minutes)		Recruit survey duration (minutes)	
	Count	Median	Count	Median	Count	Median
1 person	444	8	55	8	499	8
2 people	599	13	37	13	636	13
3 people	176	14	6	20	182	15
4 or more people	179	15	2	24	181	16
Total	1,398	12	100	10	1,498	12

TABLE 8: RETRIEVAL INTERVIEW LENGTH BY HOUSEHOLD SIZE (WEB AND CALL CENTER)

Diary count	WEB		CALL CENTER		COMBINED	
	Retrieval survey duration (minutes)		Retrieval survey duration (minutes)		Retrieval survey duration (minutes)	
	Count	Median	Count	Median	Count	Median
1 person	439	14	64	12.5	499	14
2 people	596	22	38	19.5	636	22
3 people	175	24	7	16	182	24
4 or more people	177	30	4	30	181	30
Total	1,387	20	113	14	1,498	20

5.0 DATA MONITORING, PROCESSING, AND PREPARATION

5.1 DATABASE SETUP AND DATA MONITORING

The steps for data preparation, quality control, and data deliverables for the 2018 RHTS are shown in Table 9. This table includes the primary tasks conducted prelaunch, during data collection, and post-data-collection.

TABLE 9: DATA PREPARATION AND QUALITY CONTROL BY SURVEY PHASE

PHASE	TASK/PRODUCT
Prelaunch	Set up survey administration table
	Set up “data collect” SQL views on servers
	Set up SPSS syntax files
	Run automated testing procedure on recruit survey
	Write-out testing/review on servers (see Quality Control and Review, below)
	Upload survey to production/request servers
	Spot checks on servers
	Update SQL/SPSS syntax on servers
During data collection	RECRUIT LAUNCH (start monitoring responses)
	Monitor data on servers
	Monitor errors, dropouts, overall response rates
	RETRIEVAL LAUNCH (check for diary responses)
	Confirm survey closure
Post-data-collection	Clean/process data
	Identify/flag data corrections/derivations
	Export final datasets
	Weight datasets
	Document data cleaning/create dataset guide, codebook
	Write final report, including appendices
	Deliver final datasets and documentation

5.2 QUALITY CONTROL AND REVIEW

The primary steps for data write-out review are described below:

- **Generate frequency tables for all variables** (excluding free-response and unique variables, such as reported home latitude/longitude).
- **Review frequency tables against expected survey logic.**
 - Were there any values outside the allowable range?
 - Were there responses for all the categories?
 - Did sums match across tables (e.g., sum of reported household vehicles equals count of vehicles in vehicle table)?
- **Conduct “spot checks”** to confirm that all the metadata variables are present, that text strings are not truncated, and values are overwritten if a survey response is changed.

5.3 DATASET PREPARATION

Data quality assurance and quality control happen during all stages of the project, from questionnaire and sample design to final deliverables. During and after data collection, responses were cleaned to assure the quality of the final data. This section discusses the data preparation process and summarizes steps to prepare the final datasets.

Inclusion Criteria

Of the 30,500 households invited to participate in the main study, 1,498 completed both the recruit and diary/trip reporting portions of the study and reported home locations within the TRM study area. RSG reviewed frequency distributions for all of the categorical variables to confirm that the correct numbers of responses were recorded and that the response distributions generally fell within expected ranges.

Derived and Calculated Variables

In addition to the core variables reported by respondents, RSG derived several variables to facilitate downstream data weighting and analysis. Examples of these derived variables include:

0. The number of adults in each household
1. The number of workers in each household
2. The number of children in each household
3. The age range of all persons
4. TRM time period (i.e., AM Peak, PM Peak, Midday, and Night)
5. The number of trips reported per household

All derived variables were labeled as such in the data codebook (Appendix C) and in the unweighted survey tabulations (Appendix D).

RSG also calculated several geographic variables:

<i>Home_loc_fips</i>	5-digit county FIPS (Federal Information Processing Standard)
<i>Home_loc_puma</i>	5-digit PUMA (Public Use Microdata Area)
<i>Home_loc_tract</i>	6-digit Census tract
<i>Home_loc_bg</i>	12-digit Census block group
<i>Home_loc_taz</i>	TAZ (Traffic Analysis Zone) of the TRM

Note: The Census tract identifiers (i.e., “020400”), as provided, are only unique within a state and county, whereas the Census block group identifiers are unique across counties and states.

Data Flags

Several data flags were included in the deliverable, to be leveraged during data analysis. These include:

<i>Home_loc_region</i>	Flags households outside of the model region
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<i>Personhh_income_flag</i>	Flags inconsistent household income and worker earnings
<i>Education_flag</i>	Flags inconsistent reported educational attainment status and current school type
<i>School_mode_flag</i>	Flags non-K-12 students who reported taking school bus to school
<i>Last_trip</i>	Flags last trip of travel day
<i>Prepop</i>	Flags trips that were copied from previously reported trips by other HH members whom the respondent traveled with
<i>Origin_region</i>	Flags trips that start within model region
<i>Destination_region</i>	Flags trips that end within model region
<i>Quality_flag</i>	Flags trips with potential quality concerns (see data codebook in Appendix C for full details)

Dropped Variables

Several variables were removed from the final dataset because they contained no information, even though they were defined in the questionnaire and were programmed into the survey:

- No household had more than nine household members, so trip indicator variables for household members 10, 11, and 12 were removed.
- No individual reported making a transit trip comprised of more than three transfers (i.e., four transit systems/lines), so variables describing a fifth transit system/line were removed.

6.0 EXPANSION AND WEIGHTING

Household travel surveys sample a not-necessarily-representative fraction of a region's population, so it is necessary to perform data expansion and weighting 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 process addresses 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 should review the weighting memo, provided in Appendix E, for full details on the 2018 RHTS expansion and weighting process.

7.0 SURVEY RESULTS

The final survey dataset comprises four different “levels” of data:

- Household-level data
- Person-level data
- Vehicle-level data
- Trip-level data

This section of the report summarizes survey responses at all of these levels, presenting unexpanded/unweighted (“Sample”) and expanded/weighted (“2018 RHTS Expanded”) survey results side-by-side. Some tables also include corresponding ACS data (5-year, 2013-2017, the most recent available).

Table 10 summarizes the unweighted samples and expanded/weighted/adjusted counts across key dimensions. Note that the weighted and expanded trips in this table (in the “2018 RHTS Expanded” column) were calculated using the 2016 HTS rMove adjustment factors, as the 2018 RHTS did not include an rMove component of its own. Given that trips are typically underreported in online surveys, this adjustment factor results in increased person and household trip rates within the weighted data to more accurately reflect the travel behavior in the region. The household trip rate increases more significantly than the person trip rate because the household rate reflects increased trip rates for multiple people in the household.

The expanded/weighted values in this report are based on a weighting process that, aside from using the 2016 HTS rMove adjustment factors for trips, only incorporates 2018 survey data; in the final data deliverable, RSG also provided a set of household and trip weights based on the combined set of 2016 HTS and 2018 RHTS responses.

TABLE 10: 2018 HTS RESULTS SUMMARY

	SAMPLE HHS	2018 RHTS EXPANDED
Households	1,498	694,488
Mean HH Size	2.08	2.46
Persons	3,119	1,710,633
Vehicles	2,536	1,318,438
Mean Vehicles per HH	1.69	1.90
Trips	12,345	7,224,822
Mean Trips per HH	8.24	10.40
Mean Trips per Person	3.96	4.22

7.1 HOUSEHOLD-LEVEL DATA

Table 11 shows household (HH) counts by study-area county. 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.

Household size, income, and vehicle ownership typically impact travel behavior.

Table 12 through Table 14 show survey results and ACS estimates of households for these three variables. The observable differences between the survey results and the ACS 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. 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. The original sample plan included compensatory oversampling to improve the overall sample rate of households with incomes below \$25,000. This compensatory oversampling could be improved in the future by increasing invitation rate in these block groups or by targeting households based on estimated income from the sample provider. The latter approach – which had not yet been tested at the time of the 2018 study – 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 11: HOUSEHOLD SURVEY RESULTS BY COUNTY

COUNTY	SAMPLE HHs	% OF SAMPLE HHS	2018 RHTS EXPANDED HHs	% OF 2018 RHTS EXPANDED HHs	2017 HHs (2013-2017 ACS)	% OF 2017 HHs (ACS)
Durham	420	28.0%	120,926	17.4%	120,936	17.4%
Orange	210	14.0%	60,529	8.7%	52,160	7.5%
Wake	705	47.1%	382,407	55.1%	381,971	55.0%
Chatham*	34	2.3%	13,097	1.9%	19,333	2.8%
Franklin*	22	1.5%	25,401	3.7%	21,524	3.1%
Granville*	10	0.7%	9,753	1.4%	12,168	1.8%
Harnett*	13	0.9%	15,217	2.2%	13,466	1.9%
Johnston*	66	4.4%	55,529	8.0%	57,854	8.3%
Nash*	0	0%	0	0.0%	1,433	0.2%
Person*	18	1.2%	11,629	1.7%	13,643	2.0%
Total	1,498	100.0%	694,488	100.0%	694,488	100.0%

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

TABLE 12: HOUSEHOLD SIZE

HH SIZE	SAMPLE HHS	% OF SAMPLE HHS	2018 RHTS EXPANDED HHS	% OF 2018 RHTS EXPANDED HHS	2017 HHS (2013-2017 ACS)	% OF 2017 HHS (ACS)
1 person	499	33.3%	186,941	26.9%	186,941	26.9%
2 people	636	42.5%	235,280	33.9%	235,280	33.9%
3 people	182	12.1%	115,846	16.7%	115,846	16.7%
4 people	127	8.5%	98,729	14.2%	98,729	14.2%
5 or more people	54	3.6%	57,692	8.3%	57,692	8.3%
Total	1,498	100%	694,488	100.0%	694,488	100.0%

TABLE 13: HOUSEHOLD INCOME (REPORTED OR IMPUTED IF NOT REPORTED)

HH INCOME	SAMPLE HHS	% OF SAMPLE HHS	2018 RHTS EXPANDED HHS	% OF 2018 RHTS EXPANDED HHS	2017 HHS (2013-2017 ACS)	% OF 2017 HHS (ACS)
Under \$25,000	207	13.8%	116,341	16.8%	116,341	16.8%
\$25,000-\$49,999	274	18.3%	148,897	21.4%	148,897	21.4%
\$50,000-\$74,999	287	19.2%	122,970	17.7%	122,970	17.7%
\$75,000-\$99,999	203	13.6%	90,939	13.1%	90,939	13.1%
\$100,000 or more	527	35.2%	215,341	31.0%	215,341	31.0%
Total	1,498	100.0%	694,488	100.0%	694,488	100.0%

TABLE 14: VEHICLE OWNERSHIP

HH VEHICLES	SAMPLE HHS	% OF SAMPLE HHS	2018 RHTS EXPANDED HHS	% OF 2018 RHTS EXPANDED HHS	2017 HHS (2013-2017 ACS)	% OF 2017 HHS (ACS)
0 vehicles	109	7.3%	35,060	5.1%	35,060	5.1%
1 vehicle	554	37.0%	218,213	31.4%	218,213	31.4%
2 vehicles	606	40.4%	289,728	41.7%	289,728	41.7%
3 or more vehicles	229	15.3%	151,487	21.8%	151,487	21.8%
Total	1,498	100.0%	694,488	100.0%	694,488	100.0%

7.2 PERSON-LEVEL DATA

Table 15 through Table 18 show person-level study results. Like in many household travel surveys, the 65-years-and-older age group participated at a rate above that of the general population, while individuals aged 18-24 participated at a lower rate. Non-white races were also more difficult to reach in this study than white respondents.

Note that the weighting process for this study used household-level targets rather than person-level targets, so the sum of household weights at the person level (labeled “2018 RHTS Expanded Persons”) does not perfectly match the 2013-2017 ACS estimates.

TABLE 15: AGE DISTRIBUTION

PERSON AGE	SAMPLE PERSONS	% OF SAMPLE PERSONS	2018 RHTS EXPANDED PERSONS	% OF 2018 RHTS EXPANDED PERSONS	2017 PERSONS (2013-2017 ACS)	% OF 2017 PERSONS (ACS)
Under 18 years	548	17.6%	409,976	24.0%	437,718	23.7%
18-24 years	198	6.3%	100,122	5.9%	182,347	9.9%
25-34 years	558	17.9%	177,934	10.4%	266,267	14.4%
35-44 years	432	13.9%	148,031	8.7%	269,331	14.6%
45-54 years	375	12.0%	316,382	18.5%	260,687	14.1%
55-64 years	417	13.4%	220,555	12.9%	213,638	11.6%
65 years or older	591	18.9%	337,633	19.7%	215,670	11.7%
Total	3,119	100.0%	1,710,633	100.0%	1,845,658	100.0%

TABLE 16: GENDER DISTRIBUTION

PERSON GENDER	SAMPLE PERSONS	% OF SAMPLE PERSONS	2018 RHTS EXPANDED PERSONS	% OF 2018 RHTS EXPANDED PERSONS	2017 PERSONS (2013-2017 ACS)	% OF 2017 PERSONS (ACS)
Male	1,411	45.2%	756,030	45.03%	895,836	48.5%
Female	1,669	53.5%	923,058	54.97%	949,822	51.5 %
Transgender	4	0.1%	2,299	-	-	-
Non-binary / third gender	3	0.1%	642	-	-	-
Prefer not to answer	32	1.0%	28,604	-	-	-
Total	3,119	100.0%	1,710,633	100.0%	1,845,658	100.0%

Note: The ACS does not include transgender, non-binary, or non-response figures.

TABLE 17: RACE DISTRIBUTION

PERSON RACE	SAMPLE PERSONS	% OF SAMPLE PERSONS	2018 RHTS EXPANDED PERSONS	% OF 2018 RHTS EXPANDED PERSONS	2017 PERSONS (2013-2017 ACS)	% OF 2017 PERSONS (ACS)
Asian	149	6.5%	38,364	3.3%	94,138	5.1%
Black or African American	251	10.9%	143,436	12.4%	406,425	22.0%
White	1,843	80.0%	946,947	82.1%	1,221,779	66.2%
Other (e.g., American Indian, Native Hawaiian)	33	1.4%	19,340	1.7%	72,162	3.9%
Two or more races	28	1.2%	5,868	0.51%	51,154	2.8%
Valid Response Total	2,304	100.0%	1,153,955	100.0%	1,845,658	100.0%
Prefer not to answer	267	10.4%	146,702	11.3%	-	-
Total	2,571	100.0%	1,300,657	100.0%	1,845,658	100.0%

Note: The ACS totals here represent the entire population, while the race figures for the study are for adults (age 18+) only.

TABLE 18: EMPLOYMENT STATUS (AGE 18+)

EMPLOYMENT STATUS	SAMPLE PERSONS	% OF SAMPLE PERSONS	2018 RHTS EXPANDED PERSONS	% OF 2018 RHTS EXPANDED PERSONS
Employed full-time (paid)	1,240	77.5%	605,507	70.9%
Employed part-time (paid)	200	12.5%	139,071	16.3%
Self-employed	161	10.1%	108,960	12.8%
Work-for-pay total	1,601	100.0%	853,538	100.0%
Unpaid volunteer/unpaid intern	15	0.6%	7,106	0.5%
Homemaker	117	4.6%	75,406	5.8%
Retired	585	22.8%	274,836	21.1%
Not currently employed	253	9.8%	89,772	6.9%
Total	2,571	100.0%	1,300,657	100.0%

7.3 TRIP-LEVEL DATA

Overall trip rates were calculated by dividing the total number of trips by the total number of participating households or persons. Approximately 2.9% of households and 9.5% of people reported making no trips on their travel day; these households and individuals were included in average-trip-rate calculations, regardless. Note that the weighted and expanded trips in the tables in this section (labeled “2018 RHTS Expanded Trips”) were calculated using the 2016 HTS rMove adjustment factors.

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 19: PERSON TRIPS AND TRIP RATES BY HOUSEHOLD SIZE

HOUSEHOLD SIZE	TRIP RECORDS	RAW TRIP RATE	2018 RHTS EXPANDED TRIPS	2018 RHTS EXPANDED TRIP RATE
1 person	2,333	4.68	921,913	4.93
2 people	5,110	8.03	2,014,809	8.56
3 people	1,938	10.65	1,343,578	11.60
4 people	1,881	14.81	1,645,122	16.66
5 or more people	1,083	20.06	1,299,400	22.52
Total	12,345	8.24	7,224,822	10.40

TABLE 20: PERSON TRIPS AND TRIP RATES BY GENDER

GENDER	TRIP RECORDS	RAW TRIP RATE	2018 RHTS EXPANDED TRIPS	2018 RHTS EXPANDED TRIP RATE
Male	5,380	3.81	2,977,669	3.94
Female	6,836	4.10	4,163,978	4.51
Transgender	20	5.00	3,324	1.45
Non-binary / third gender	7	2.33	2,224	3.46
Prefer not to answer	102	3.19	77,627	2.71
Total	12,345	3.96	7,224,822	4.22

TABLE 21: PERSON TRIPS AND TRIP RATES BY AGE

AGE	TRIP RECORDS	RAW TRIP RATE	2018 RHTS EXPANDED TRIPS	2018 RHTS EXPANDED TRIP RATE
Under 18 years	1,686	3.15	1,333,703	3.44
18-24 years	621	2.98	353,223	3.02
25-34 years	2,268	4.06	840,101	4.72
35-44 years	1,971	4.56	831,361	5.62
45-54 years	1,667	4.45	1,605,941	5.08
55-64 years	1,691	4.06	846,026	3.84
65 years or older	2,441	4.13	1,414,467	4.19
Total	12,345	3.96	7,224,822	4.22

TABLE 22: PERSON TRIPS AND TRIP RATES BY RACE (AGE 18+)

RACE	TRIP RECORDS	RAW TRIP RATE	2018 RHTS EXPANDED TRIPS	2018 RHTS EXPANDED TRIP RATE
Asian	503	3.38	145,853	3.80
Black or African American	851	3.39	514,550	3.59
White	8,132	4.41	4,558,733	4.81
Other (e.g., American Indian, Native Hawaiian, etc.)	131	3.97	91,969	4.76
Two or more races	144	5.14	35,067	5.98
Prefer not to answer	898	3.36	544,946	3.71
Total	10,659	4.15	5,891,118	4.53

TABLE 23: PERSON TRIPS AND TRIP RATES BY DRIVER LICENSURE

HAS DRIVER'S LICENSE	TRIP RECORDS	RAW TRIP RATE	2018 RHTS EXPANDED TRIPS	2018 RHTS EXPANDED TRIP RATE
Yes, Driver's license	10,184	4.23	5,688,177	4.63
Yes, Learner's permit	66	2.06	48,805	2.10
No	2,095	3.07	1,487,840	3.25
Total	12,345	3.96	7,224,822	4.22

TABLE 24: PERSON TRIPS AND TRIP RATES BY EMPLOYMENT STATUS

WORKER STATUS	TRIP RECORDS	RAW TRIP RATE	2018 RHTS EXPANDED TRIPS	2018 RHTS EXPANDED TRIP RATE
No, not worker	5,514	3.66	3,292,596	3.89
Yes, worker (Paid: full-time, part-time, self-employed)	6,831	4.24	3,932,226	4.55
Total	12,345	3.96	7,224,822	4.22

TABLE 25: PERSON TRIPS AND TRIP RATES BY UNIVERSITY/COLLEGE STUDENT STATUS

UNIVERSITY STUDENT STATUS	TRIP RECORDS	RAW TRIP RATE	2018 RHTS EXPANDED TRIPS	2018 RHTS EXPANDED TRIP RATE
No, not university student	11,326	3.97	6,880,222	4.21
Yes, university student (2-year college, 4-year college, graduate or professional school)	1,019	3.86	344,599	4.54
Total	12,345	3.96	7,224,822	4.22

TABLE 26: NUMBER OF PERSON TRIPS BY DESTINATION ACTIVITY

TRIP DESTINATION ACTIVITY	TRIP RECORDS (N)	TRIP RECORDS (%)	2018 RHTS EXPANDED TRIPS (N)	2018 RHTS EXPANDED TRIPS (%)
At home activity, not working (for pay) or schooling	3,772	30.6%	2,080,787	28.8%
At home, working (for pay)	238	1.9%	128,917	1.8%
At work (not home), working for pay	1,503	12.2%	710,569	9.8%
Other work-related activity (meeting, visit, sales call, etc.)	283	2.3%	144,737	2.0%
Attend school/class	754	6.1%	560,411	7.8%
Other school-related activity	182	1.5%	133,815	1.9%
Routine shopping (grocery, gas, clothing, convenience store, household maintenance, etc.)	1,322	10.7%	879,334	12.2%
Shopping for major purchase/specialty item (appliance, electronics, new vehicle, major household repairs, etc.)	91	0.7%	98,144	1.4%
Dining out/take-out/coffee (eat at restaurant, get take-out/fast-food)	757	6.1%	449,986	6.2%
Pick up someone	333	2.7%	264,604	3.7%
Drop off someone	355	2.9%	278,505	3.9%
Change type of transportation/Transfer to (take bus, airplane, park car or pickup parked car if walk 2+ blocks, etc.)	369	3.0%	138,537	1.9%
Household errands (bank/ATM, post office, dry cleaning, car services, etc.)	345	2.8%	221,861	3.1%
Personal business (visit government office, attorney, accountant, etc.)	172	1.4%	121,378	1.7%
Medical visit (doctor, dentist, etc.)	230	1.9%	129,595	1.8%

TRIP DESTINATION ACTIVITY	TRIP RECORDS (N)	TRIP RECORDS (%)	2018 RHTS EXPANDED TRIPS (N)	2018 RHTS EXPANDED TRIPS (%)
Recreation/entertainment (walk the dog, exercise/workout, go to a movie)	1,072	8.7%	547,021	7.6%
Social (visit friends/relatives)	325	2.6%	186,490	2.6%
Religious, civic, or volunteer	219	1.8%	136,872	1.9%
Other (not at home) ⁷	23	0.2%	13,259	0.2%
Total	12,345	100.0%	7,224,822	100.0%

TABLE 27: NUMBER OF PERSON TRIPS BY MODE

MODE	TRIP RECORDS (N)	TRIP RECORDS (%)	2018 RHTS EXPANDED TRIPS (N)	2018 RHTS EXPANDED TRIPS (%)
Vehicle (or motorcycle/moped) in household	9,136	74.0%	5,721,285	79.2%
Other vehicle (e.g., rental, friend's car, carshare, taxi, work car)	443	3.6%	302,244	4.2%
Any bus (e.g., public bus, school/university bus, paratransit)	637	5.2%	315,119	4.4%
Walk/jog/wheelchair	1,877	15.2%	798,087	11.1%
Bicycle	173	1.4%	44,201	0.6%
Other	79	0.6%	43,886	0.6%
Total	12,345	100.0%	7,224,822	100.0%

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.

⁷ Respondents marked more than 23 destinations with an activity code of “Other (not at home)”, but then some of them were converted to other activity codes by NCSU-ITRE staff, based on the entries made in the free-response text field that appears when “Other (not at home)” is selected, as well as on the name that the respondent gave to the destination in question.

Note – some participants reported work and school locations outside the study region (46 and 34 locations, respectively). These locations are not included on the maps below.

FIGURE 7: PRIMARY HOME LOCATIONS FOR COMPLETE HOUSEHOLDS (NOISE ADDED)

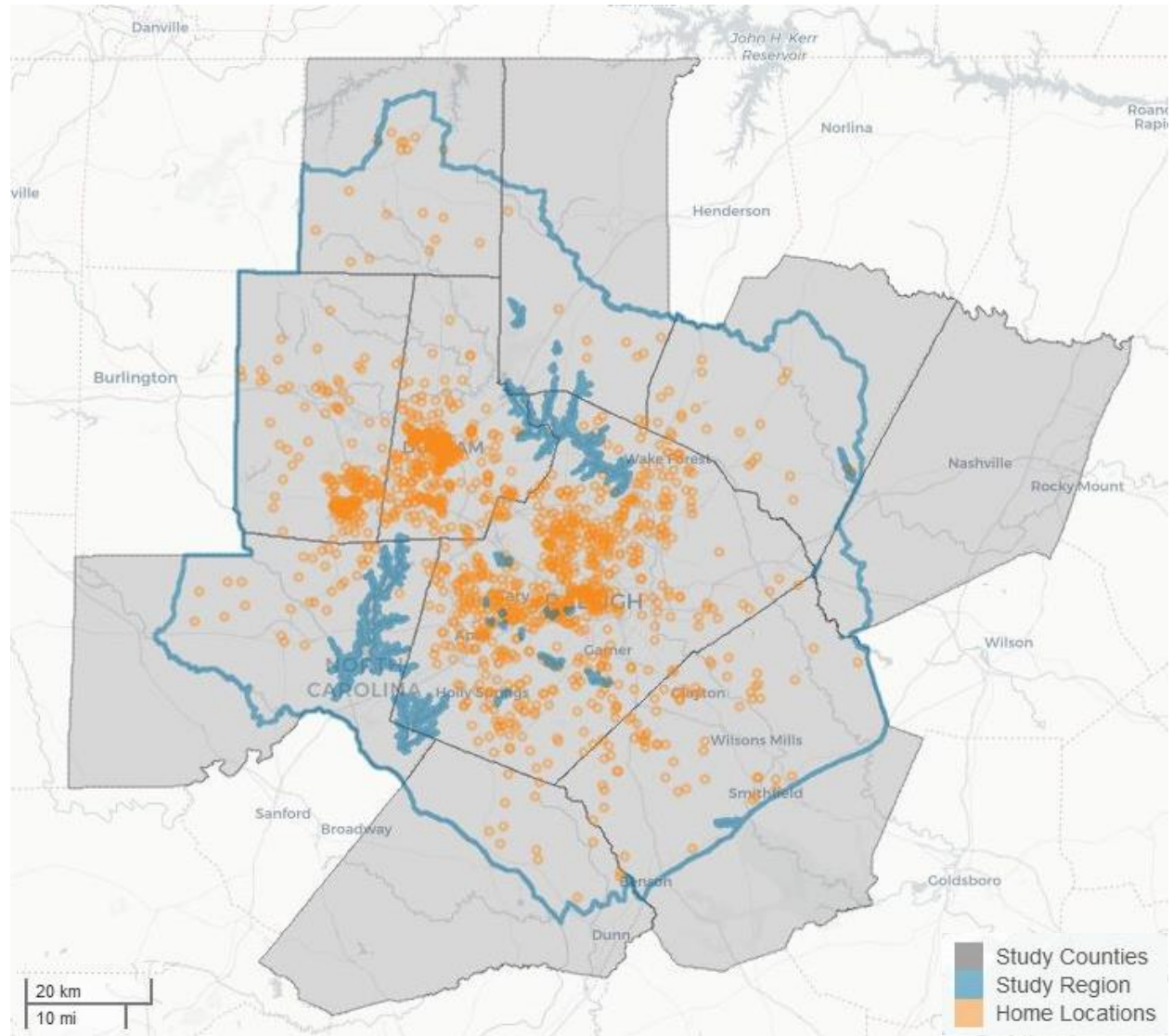


FIGURE 8: REPORTED NON-HOME PRIMARY WORK LOCATIONS FOR FULL-TIME, PART-TIME, SELF-EMPLOYED, AND VOLUNTEER/INTERN WORKERS IN COMPLETE HOUSEHOLDS (NOISE ADDED; NOT ALL WORKERS REPORTED A PRIMARY WORK LOCATION)

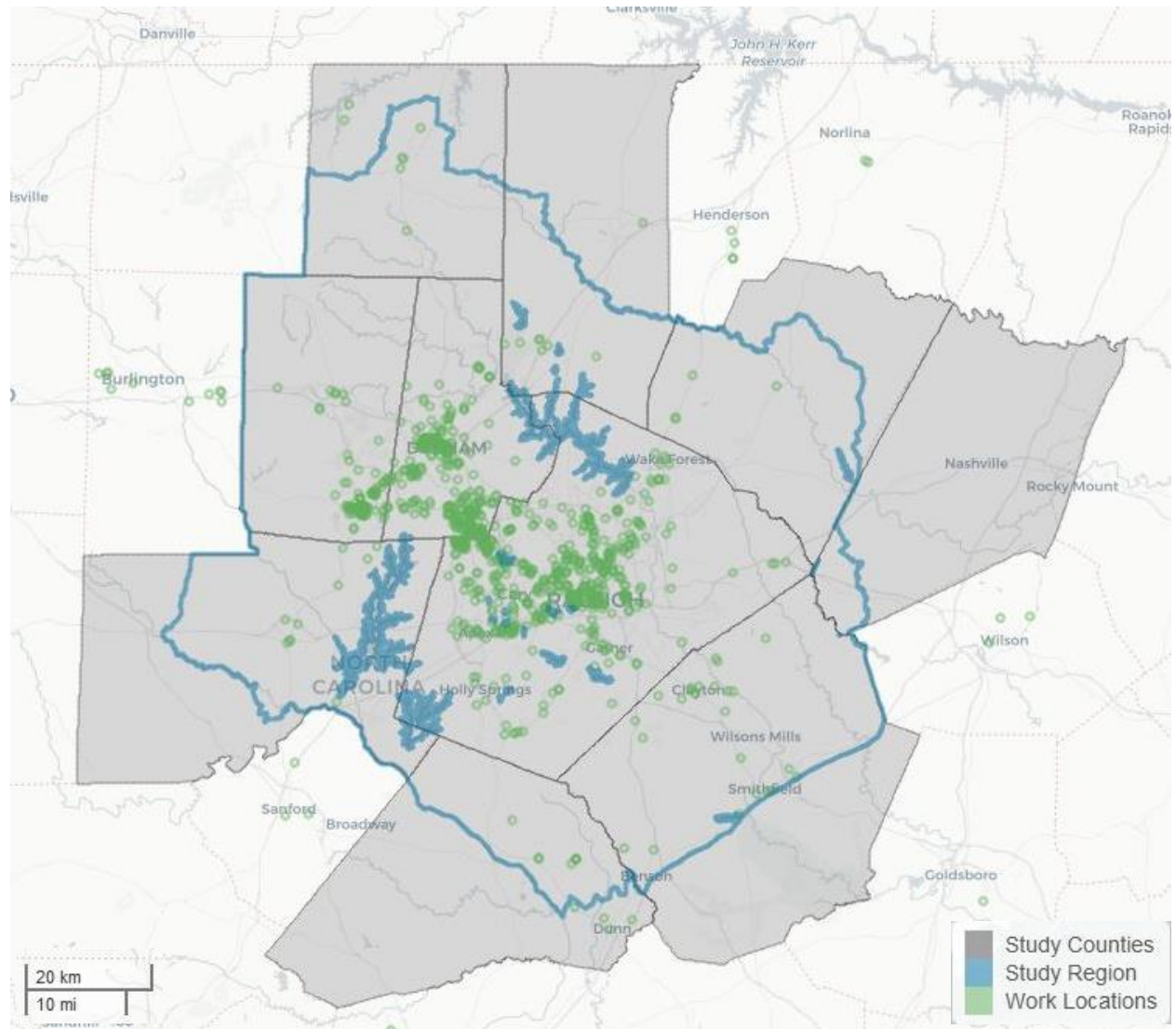
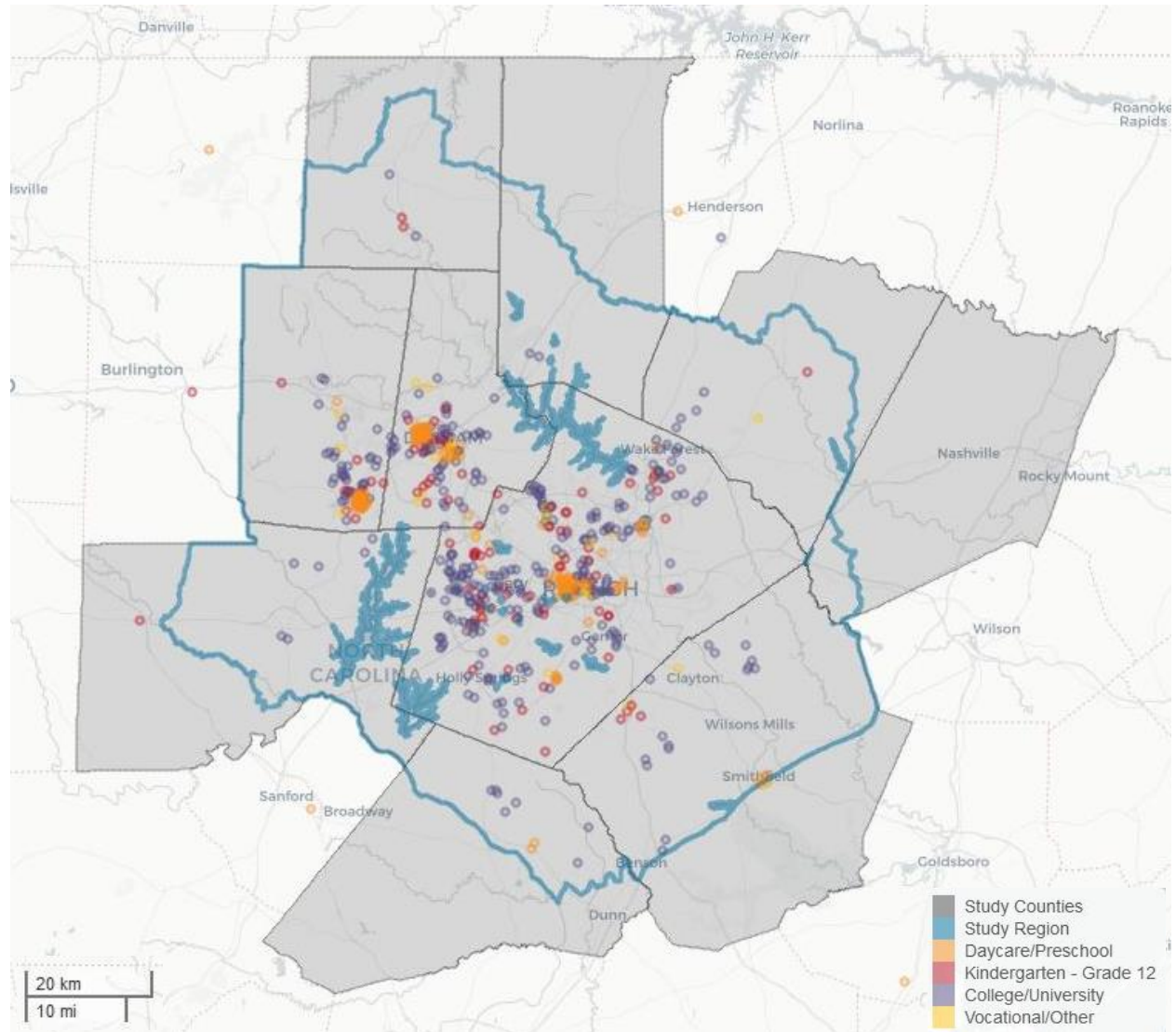


FIGURE 9: REPORTED NON-HOME SCHOOL LOCATIONS FOR STUDENTS IN COMPLETE HOUSEHOLDS BY SCHOOL TYPE (NOISE ADDED)



8.0 SUMMARY

The 2018 Triangle Region Recurrent Household Travel Study (2018 RHTS) 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, data collection, and data weighting. A total of 1,498 households completed the survey. These households provided data critical for updating and developing the Triangle Regional Model.

9.0 APPENDICES

- A. QUESTIONNAIRE**
- B. PRINT MATERIALS**
- C. DATA CODEBOOK**
- D. UNWEIGHTED TABULATIONS**
- E. WEIGHTING MEMO**



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