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FINAL REPORT

2016 TRIANGLE REGION HOUSEHOLD TRAVEL SURVEY



PREPARED FOR:

NORTH CAROLINA STATE UNIVERSITY–
INSTITUTE FOR TRANSPORTATION RESEARCH AND EDUCATION
(NCSU–ITRE)

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

SUBMITTED BY:

RSG

IN COOPERATION WITH:

ETC INSTITUTE
PLANNING COMMUNITIES (DBE, WBE, SPSF)

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PREPARED FOR:
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CONTENTS

ACKNOWLEDGEMENTS.....	1
1.0 INTRODUCTION.....	2
1.1 Study Overview	2
Study Area	2
Study Objectives	3
Study Timeline	5
1.2 Pilot Survey Overview	7
Results	7
Changes Implemented.....	8
1.3 Main Survey Overview.....	9
1.4 Smartphone GPS Survey Overview	10
2.0 SURVEY DESIGN.....	11
2.1 Overview.....	11
2.2 Household Questionnaire (Recruit Survey).....	12
Household Data	13
Person Data	13
Vehicle Data.....	14
2.3 Retrieval Survey (24-Hour Trip/Activity Diary)	14
Trip Information	14
3.0 SURVEY BRANDING, MATERIALS AND COMMUNICATION	17
3.1 Program Branding	17



3.2 Print Materials.....	17
3.3 Project Website	17
3.4 Recruitment and Retrieval Methods	18
3.5 Participant Reminders	19
3.6 Survey Incentives	19
4.0 SURVEY SAMPLING	20
4.1 Sample Frame and Sample Area	20
4.2 Sample Methods and Rates	21
4.3 Demographic Targets	23
4.4 Travel Date Assignment	24
5.0 PUBLIC OUTREACH	25
5.1 Objectives	25
5.2 Target Audiences	25
5.3 Methods.....	25
Postal Mail.....	25
Public Service Announcements/Press Releases	26
Constant Contact Notifications.....	26
Website Posts	27
Messages and Timing	27
Survey Initiation.....	27
Survey Reminders.....	28
Review and Implementation Schedule.....	28
5.4 Evaluation.....	29
6.0 DATA MONITORING, PROCESSING AND PREPARATION	34
6.1 Database Setup and Data Monitoring	34
6.2 Quality Control and Review	35
6.3 Dataset Preparation.....	35
Exclusion Criteria	35
Geographic Data Checks	36
Derived and Calculated Variables.....	36
Data Flags	37
Dropped Variables	37

Income Imputation.....	38
7.0 SURVEY RESULTS.....	41
7.1 Response Summary	41
7.2 Household Results	42
7.3 Trip Rates and Trip Details.....	44
7.4 Geographic Coverage	49
7.5 Respondent Experience	52
8.0 EXPANSION AND WEIGHTING	53
8.1 The Role of Weighting	53
8.2 First Stage Expansion	53
8.3 Weighting Targets and Processes	54
8.4 Household, Person, and Vehicle Weights	57
8.5 Trip Weights and Trip Correction Factors	59
9.0 WEIGHTED SURVEY RESULTS	63
9.1 Household-Level Data	63
9.2 Person-Level Data.....	65
9.3 Trip-Level Data	67
10.0 SUMMARY.....	72
11.0 APPENDICIES	73
A. Questionnaire	73
B. Survey Screenshots	73
C. Print Materials.....	73
D. Example Email Reminders	73
E. Public Outreach Materials	73
F. Open-ended Survey Comments.....	73
G. Dataset Guide.....	73
H. Data Codebook.....	73
I. Unweighted Tabulations	73
J. Weighted Tabulations.....	73
K. Weighting Memo.....	73
L. Smartphone GPS Data Collection	73



List of Figures

FIGURE 1: STUDY AREA.....	3
FIGURE 2: STUDY OVERVIEW GRAPHIC.....	12
FIGURE 3: MAIN SURVEY ACTIVITY CODES.....	15
FIGURE 4: TRIANGLE TRAVEL SURVEY BRANDING	17
FIGURE 5: TRIANGLE TRAVEL SURVEY “HOME” PAGE	18
FIGURE 6: SURVEY SAMPLE AREA BLOCK GROUPS BY COUNTY	21
FIGURE 7: BLOCK GROUPS FOR OVERSAMPLING	22
FIGURE 8: PARTICIPANT FEEDBACK.....	32
FIGURE 9: PRIMARY HOME LOCATIONS: COMPLETE HOUSHOLDS	49
FIGURE 10: PRIMARY WORK LOCATIONS FOR WORKERS IN COMPLETE HOUSEHOLDS	50
FIGURE 11: SCHOOL LOCATIONS FOR STUDENTS IN COMPLETE HOUSEHOLDS BY SCHOOL TYPE	51
FIGURE 12 DISTRIBUTION OF HOUSEHOLD FINAL WEIGHTS	58
FIGURE 13 AVERAGE TRIPS PER DAY BY DATA TYPE AND AGE GROUP (WEIGHTED DATA)	61
FIGURE 14 HISTOGRAM OF FINAL TRIP WEIGHTS.....	61

List of Tables

TABLE 1: SURVEY ACTIVITIES AND DESCRIPTION MATRIX.....	4
TABLE 2: PROJECT TIMELINE, TASKS, AND DELIVERABLES.....	5
TABLE 3: PILOT SURVEY COMPLETION SUMMARY	8
TABLE 4: MAIN SURVEY PARTICIPATION SUMMARY	9
TABLE 5. HOUSEHOLDS BY INCENTIVE TYPE	19
TABLE 6: BLOCK GROUPS FOR OVERSAMPLING.....	22
TABLE 7: EXAMPLE IDENTIFICATION OF OVERSAMPLE BLOCK GROUPS	23
TABLE 8: TARGET SAMPLE SIZES AND RATES.....	23
TABLE 9: PUBLIC OUTREACH ACTIVITES AND TIMING	28
TABLE 10: PUBLIC OUTREACH RESULTS.....	30
TABLE 11: PARTICIPANT FEEDBACK	31
TABLE 12: TARGETED HOUSEHOLD TYPES	33
TABLE 13: DATA PREPARATION AND QUALITY CONTROL BY SURVEY PHASE	34
TABLE 14: FINAL (IMPUTED) INCOME CATEGORIES VERSUS REPORTED INCOME.....	40
TABLE 15: FINAL SAMPLE SIZES AND RATES.....	41
TABLE 16: FINAL SAMPLE SIZE AND SAMPLE RATES BY COUNTY	41
TABLE 17: CONVERSION RATES BY TARGET SEGMENT	42
TABLE 18: RESPONSE SUMMARY (HOUSEHOLD, PERSON, VEHICLE, AND TRIP)	42
TABLE 19: HOUSEHOLD PARTICIPATION BY DAY OF WEEK	42
TABLE 20: HOUSEHOLD SIZE	42
TABLE 21: NUMBER OF HOUSEHOLD VEHICLES	42
TABLE 22: HOUSEHOLD INCOME.....	43
TABLE 23: AGE DISTRIBUTION.....	43
TABLE 24: GENDER DISTRIBUTION	43

TABLE 25: RACE DISTRIBUTION	44
TABLE 26: HOUSEHOLD AND PERSON TRIP RATES.....	44
TABLE 27: HOUSEHOLD TRIP RATE BY COUNTY.....	44
TABLE 28: HOUSEHOLD TRIP RATE BY HOUSEHOLD SIZE	45
TABLE 29: TRIP RATE BY NUMBER OF HOUSEHOLD VEHICLES.....	45
TABLE 30: PERSON-LEVEL TRIP RATE BY COUNTY.....	45
TABLE 31: TRIP RATE BY GENDER.....	45
TABLE 32: TRIP RATE BY AGE	46
TABLE 33: TRIP RATE BY RACE.....	46
TABLE 34: TRIP RATE BY DRIVERS LICENSURE.....	46
TABLE 35: TRIP RATE BY UNIVERSITY STUDENT STATUS (18+).....	46
TABLE 36: TRIP RATE BY WORKER STATUS (16+).....	46
TABLE 37: NUMBER OF TRIPS BY MODE	47
TABLE 38: NUMBER OF TRIPS BY DESTINATION ACTIVITY TYPE.....	47
TABLE 39: TYPICAL MODE TO WORK, EMPLOYED/VOLUNTEER ADULTS	48
TABLE 40: RECRUITMENT INTERVIEW LENGTH BY HOUSEHOLD SIZE (WEB AND CALL CENTER).....	52
TABLE 41: RETRIEVAL INTERVIEW LENGTH BY HOUSEHOLD SIZE (WEB AND CALL CENTER).....	52
TABLE 42: FIRST STAGE EXPANSION FACTORS, BY SAMPLE SEGMENT AND WEIGHTING REGION.....	53
TABLE 43: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: HH SIZE.....	56
TABLE 44: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: HH WORKERS	56
TABLE 45: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: HH VEHICLES	56
TABLE 46: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: HH INCOME.....	56
TABLE 47: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: AGE OF HEAD OF HOUSEHOLD	57
TABLE 48: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: PRESENCE OF CHILDREN.....	57
TABLE 49: MEAN VALUES OF FINAL WEIGHTS, BY SAMPLE SEGMENT AND WEIGHTING REGION.....	59
TABLE 50: 2016 SURVEY RESULTS SUMMARY.....	63
TABLE 51: HOUSEHOLD SURVEY RESULTS BY COUNTY (UNWEIGHTED, WEIGHTED, AND ACS)	64
TABLE 52: HOUSEHOLD SIZE (UNWEIGHTED, WEIGHTED, AND ACS).....	64
TABLE 53: HOUSEHOLD INCOME (UNWEIGHTED, WEIGHTED, AND ACS).....	65
TABLE 54: VEHICLE OWNERSHIP (UNWEIGHTED, WEIGHTED, AND ACS)	65
TABLE 55: AGE DISTRIBUTION (UNWEIGHTED, WEIGHTED, AND ACS).....	65
TABLE 56: GENDER DISTRIBUTION (UNWEIGHTED, WEIGHTED, AND ACS)	66
TABLE 57: RACE DISTRIBUTION (UNWEIGHTED, WEIGHTED, AND ACS)	66
TABLE 58: EMPLOYMENT STATUS (UNWEIGHTED AND WEIGHTED).....	66
TABLE 59: HOUSEHOLD AND PERSON TRIP RATES.....	67
TABLE 60: HOUSEHOLD-LEVEL TRIP COUNTS AND TRIP RATES BY COUNTY	67
TABLE 61: HOUSEHOLD TRIP COUNTS AND TRIP RATES BY HOUSEHOLD SIZE.....	67
TABLE 62: PERSON-LEVEL TRIP COUNTS AND TRIP RATES BY COUNTY	68
TABLE 63: TRIP RATES BY GENDER (WEIGHTED AND UNWEIGHTED).....	68
TABLE 64: TRIP RATES BY AGE (WEIGHTED AND UNWEIGHTED)	68
TABLE 65: TRIP COUNTS AND TRIP RATES BY RACE (WEIGHTED AND UNWEIGHTED).....	69
TABLE 66: TRIP COUNTS AND TRIP RATES BY DRIVER LICENSURE (WEIGHTED AND UNWEIGHTED).....	69
TABLE 67: TRIP COUNTS AND TRIP RATES BY WORKER STATUS (WEIGHTED AND UNWEIGHTED)	69



TABLE 68: TRIP COUNTS AND TRIP RATES BY UNIVERSITY STUDENT STATUS (WEIGHTED AND UNWEIGHTED)..... 69
TABLE 69: NUMBER OF TRIPS BY DESTINATION ACTIVITY (WEIGHTED AND UNWEIGHTED) 70
TABLE 70: NUMBERS OF TRIPS BY MODE (WEIGHTED AND UNWEIGHTED) 71
TABLE 71: TYPICAL MODE TO WORK, EMPLOYED ADULTS AND VOLUNTEERS (WEIGHTED AND UNWEIGHTED)..... 71

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Study Sponsors

North Carolina Department of Transportation (NCDOT)

GoTriangle

Capital Area Metropolitan Planning Organization (CAMPO)

Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC-MPO)



1.0 INTRODUCTION

1.1 | STUDY OVERVIEW

In summer 2015, the North Carolina State University Institute for Transportation Research and Education (NCSU-ITRE) commenced the 2016 Triangle Region Household Travel Survey (2016 HTS), branded as the Triangle Travel Survey. The 2016 HTS was conducted in order to collect current information about household and individual travel patterns for residents throughout the greater Raleigh-Durham region, also known as the greater Triangle region.

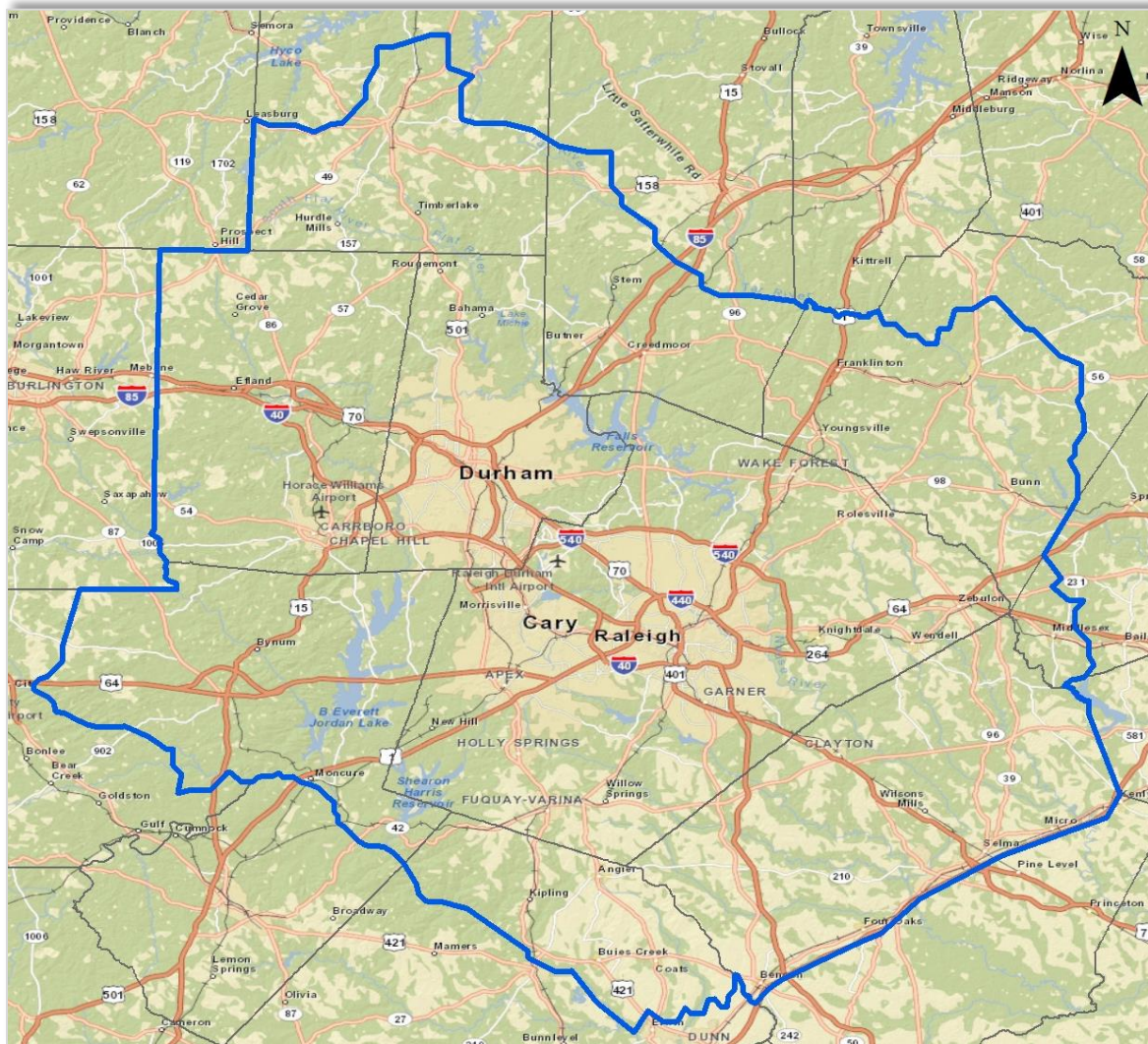
A total of 4,194 households (HHs) in 10 counties in the Triangle region completed the survey. These households provided data critical for updating and developing the Triangle Regional Model (TRM). NCSU-ITRE led the project. The technical advisory committee (TAC) for the study was composed of representatives from the North Carolina Department of Transportation (NCDOT), GoTriangle, 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 2016 HTS. ETC Institute (ETC) and Planning Communities assisted as sub-consultants to RSG.

STUDY AREA

The study area includes all of Durham, Orange, and Wake counties, along with portions of Chatham, Harnett, Johnston, Franklin, Granville, Nash, and Person counties. “The total population for this region in 2010 was 1,668,800 persons. 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 housed at the University of North Carolina, Chapel Hill. Duke University and its Medical Center is the largest single employer in the Triangle region. Raleigh is the largest municipality in the region. It was originally developed as a government center around the state capital in the downtown. In addition to the municipalities of Raleigh, Durham, and Chapel Hill, the region has many other cities and towns that are important as well, such as Cary with approximately 135,000 residents in 2010. The region also includes four major universities and several smaller colleges and universities with approximately 80,000 students.”¹ The study area outlined in blue in Figure 1, corresponds to the extent of the current TRM boundary.

¹ Raleigh-Durham Household Travel Survey RFP# 63-JGD10128, March 26, 2015

FIGURE 1: STUDY AREA



STUDY OBJECTIVES

The primary objective for the 2016 HTS was to collect complete travel information for a 24-hour weekday period from a representative sample of 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. This included (but was not limited to) low-income households, zero-vehicle households, households with students at post-secondary institutions, and households that frequently make transit trips. The last HTS in the Triangle region was conducted in 2006. Given changes in regional demographics, employment, land use, and travel patterns, more recent data were needed. The 2016 HTS provides current data about regional travel patterns, which will be used to update and enhance the TRM.

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.



The survey data collected by the 2016 HTS will provide planners with the information necessary to help regional stakeholders and other local agencies understand current transportation behaviors in order to make informed planning and policy decisions.

The study effort combined multiple, proven methods of data collection in order to efficiently complete the one-day HTS and smartphone GPS components of this study, including:

- An address-based recruitment strategy with multiple first-class mailings to all invited households
- A data collection strategy that included telephone retrieval and web survey technology
- An informative and aesthetically appealing public-facing project website and branding
- A survey-tracking website providing study results in real-time to the client team
- The utilization of smartphones for GPS data collection

Table 1 is an overview of the approach for the 2016 HTS project.

TABLE 1: SURVEY ACTIVITIES AND DESCRIPTION MATRIX

Activity	Description
Sampling	<ul style="list-style-type: none"> • Address-based sample using 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 pre-notification and study invitation packet • Targeted outbound calls to telephone match households
Reminders	<ul style="list-style-type: none"> • Postcards to all invited households • Emails to households who provided email addresses • Telephone call(s) to those indicating a preference for telephone (rather than email) reminders
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 pre-populated/saved • 100% real-time geocoding using the Google Maps API • Perception that completing the survey experience is shorter online than by phone allows for additional questions to meet other data needs

Activity	Description
Participation (Telephone)	<ul style="list-style-type: none"> • A toll-free number for respondents to call in and participate by phone • Operators use identical survey instrument to the online survey
Pilot Study	<ul style="list-style-type: none"> • Sample of at least 150 households over one week • Purpose: evaluate entire project process, including effectiveness of all survey materials and all aspects of study methodology—identify areas for improvement • Open-ended questions asked at conclusion regarding areas of confusion and suggestions for revisions • Sufficient time in the schedule for pilot evaluation and finalizing full study elements
Data Collection	<ul style="list-style-type: none"> • Collect complete data from a minimum of 4,000 households region-wide during the data collection period • An additional three-day smartphone-based GPS subsample • Real-time reporting website to monitor progress • 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"> • A pilot report and data deliverable included data analysis, survey results, and recommendations to inform the main survey effort; the pilot evaluation included a review of the survey administration, methodology, materials, and questionnaire • 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 and GPS dataset delivered at the conclusion of the study

STUDY TIMELINE

The scope of work for this project included the design and administration of a one-day household travel diary as well as a three-day smartphone GPS subcomponent. The tasks and deliverables conducted in order to complete the HTS and smartphone GPS components are documented in Table 2, along with the project schedule.

TABLE 2: PROJECT TIMELINE, TASKS, AND DELIVERABLES

Project Tasks and Deliverables	Dates
Task 1: Project Management Plan	July - August 2015
Kickoff Meeting	
Project Management Plan and Work Plan	
Detailed Project Schedule	



Project Tasks and Deliverables		Dates
Task 2: Develop Survey Sample Plan		
	Pilot Sample Memo	August 2015
	Draft Sample Plan	November 2015 - January 2016
	Final Sample Plan (updated after pilot survey)	
Task 3: Develop Survey Instruments and Data Collection Procedures		
	Draft and Final Public Awareness Plan	July - November 2015
	Draft and Final Survey Instruments (Questionnaire)	
	Draft and Final Survey Materials	
Task 4: Interviewer Training and Online Survey Quality Assurance		October 2015 & February 2016
Task 5: Conduct Pilot Survey and Evaluate Results		
	Pilot Survey Results Database	October 2015 - February 2016
	Pilot Survey Report with Recommendations	
Task 6: Refine Survey Methods, Materials, and Procedures		
	Revised Survey Methods, Materials, and Procedures	December 2015 - February 2016
	Final Version of Survey Instruments and Materials	
Task 7: Conduct Main Survey & Smartphone GPS Survey		
	Refined Survey Instruments, Materials, and Sample Plan	Late February - Early May 2016
	Report Weekly on Project Status (via email)	
Task 8: Code, Correct, and Validate the Survey Data		
	Quality control manual describing data checks and audit checks	December 2015 - May 2016
Task 9: Interim Data Deliverable		
	Report outline, draft report sections, data dictionary/codebook, and draft weighted data files	May 2016
Task 10: Weighting and Expansion		
	Draft and Final Weighting Plans	May - June 2016
Task 11: Delivery of Final Dataset		
	Final Dataset	June 2016
Task 12: Final Report		
	Final Report	June 2016

1.2 | PILOT SURVEY OVERVIEW

The pilot study for the 2016 HTS was conducted December 7-11, 2015. The objectives of the pilot survey included evaluation of the:

- Questionnaire/online survey
- Study materials
- Administration process
- Response rates
- Data quality
- Respondent burden

The pilot study aimed to collect data from 150 households in select areas of the region that represented certain household types. Households were pre-assigned one of five “travel dates” on a Monday-Friday and were offered a \$10 incentive for their participation. On their assigned travel date, all household members were asked to report their trips for that 24-hour period. Lessons learned from the pilot study were considered in the sampling plan design for the main study. A particular emphasis was placed on observed response rates (the ratio of households who complete the survey to the number of households who were invited to take the survey), as these were used directly in the design of the sampling plan for the main study.

As part of the pilot study, a group of 26 NCSU-ITRE and TAC members (including participating family members) were invited to review the rMove GPS application on March 25-27, 2016. The GPS participants were not part of the pilot study sampling or data analysis and were not offered an incentive for participation. GPS participant data (both survey data and GPS data) from the pilot study were delivered to NCSU-ITRE in order to increase their familiarity with this type of data deliverable.

RESULTS

The pilot survey response was better than predicted. A total of 228 households completed the pilot survey. The pilot sample plan used a conservative response rate of 3.5% (percent of invited households) that would fully complete the survey. Three household types that are typically hard-to-reach were targeted in the pilot sample plan:

- Type 1. Low-income households;
- Type 2. Transit-user households; and
- Type 3. Typical suburban households.

Low-income households were defined as those with annual household incomes of less than \$25,000. Transit-user households were identified as those with no vehicles or with workers who commute via transit (the former acting as a proxy for transit-user households). Typical suburban households were defined as those with annual household incomes of more than \$75,000 and a household size of three or more. The pilot survey targets were 50 household completes for each of the above block group types.

The goal for the pilot study was to collect data to evaluate the effectiveness and accuracy of the survey questionnaire design and the overall study methodology. Table 3 shows the number of invited households, households who completed the recruit survey, completed households, response rate, and conversion rate for



the pilot survey. For the 2016 HTS, a “complete” household is defined as one in which all eligible household members answer every single data element (every question) in the survey, with the exception of household income, race, ethnicity and disability for which a refusal (“prefer not to answer”) was allowed.

TABLE 3: PILOT SURVEY COMPLETION SUMMARY

Sample Type	# HHs Invited	# HHs Recruited	# HHs Completed	Response Rate*	Conversion Rate**
Type 1: Transit Users	1,525	88	69	4.5%	78.4%
Type 2: Low-Income	1,525	79	56	3.7%	70.9%
Type 3: Typical Suburban	1,525	139	103	6.7%	74.1%
Total	4,575	298	228	5.0%	76.5%
<i>*Response rate = (# of HHs Completed / # of HHs Invited)</i>					
<i>**Conversion Rate = (# of HHs Completed / # of HHs Recruited)</i>					

CHANGES IMPLEMENTED

The pilot survey effort gathered recommendations from survey participants, the client, and the TAC. RSG evaluated all comments, as well as the data output, and made additional recommendations based on open-end feedback provided by participating households. The recommended main survey updates were then summarized in five pilot study report sections: survey design, print materials, participant communications, incentive structure, and sample planning. A summary of the changes by section is provided below. More details are available in the pilot survey report.

Survey Design

The implemented main survey updates for survey design fell into three categories: write-out/logic, survey display, and updates to wording or instructions. Two write-out/logic errors/changes were discovered during the pilot study that resulted in data loss or inaccuracies. One was related to the copy-trips functionality, and the other was a transit-details write-out issue. The other logic change was not an error, but a revision to ask 16-17-year-olds that reported having a job all work questions. Some participants suggested updates to the survey display. For example, they suggested better aligning drop-down menus for some questions to ensure no overlap with the subsequent questions. The trip time reporting menu, which required significant scrolling, was also reported to be cumbersome. Several wording updates were made to clarify the intent of the questions, or to elaborate on how to report trip details (e.g., transit reporting).

Print Materials and Participant Communication

The travel log was the only print material that changed between the pilot and main surveys. The changes included revamping and simplifying the travel log table where participants reported travel times and activities. The activity list was also reordered, and some descriptions were modified for clarity. The household invitation letter, FAQs, and travel log were also translated to Spanish for the main study, and were available for download from the project website.

Incentives and Sample Planning

The types of incentives offered in the pilot survey were well-received, and no changes were made for the main study. The incentive amount offered to low-income (i.e. \$25,000 or under) and/or large (5+) households was increased from \$10 to \$20 to encourage participation from these groups. Both of these groups completed the pilot survey at a low rate when compared to their share of households in the greater Triangle region, according to data from the 2009-2013 American Community Survey (ACS).

The estimated response rates for the main survey were updated based on the pilot survey results. Two sample segments were created for the main survey: regular and oversample. For the regular sample, an estimated response rate of 5.5% was recommended, and for the oversample, a 4.0% response rate was estimated. Low-income households were included in the oversample segment, which is described in more detail in Section 4.2 Sample Methods and Rates.

1.3 | MAIN SURVEY OVERVIEW

The 2016 HTS was conducted from February 29, 2016 through April 29, 2016. The survey goal was to collect data from at least 4,000 households in the 10-county greater Triangle region. Invitation letters were mailed to 76,097 households in the study area. A total of 4,194 households completed the survey². Table 4 is a participation summary by county, based on the home address locations provided by the address vendor and used for sample planning. Only three counties (Durham, Orange, and Wake) are entirely included within the current TRM model 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 4: MAIN SURVEY PARTICIPATION SUMMARY

County	ACS N	HHs Invited	HHs Recruited	HHs Completed	Response Rate	Conversion Rate	Sample Rate
Durham	113,564	14,004	926	683	4.9%	73.8%	0.61%
Orange	51,419	6,667	563	446	6.7%	79.2%	0.86%
Wake	355,647	42,492	3,176	2,432	5.7%	76.6%	0.68%
Chatham *	17,817	2,018	189	150	7.4%	79.4%	0.83%
Franklin *	20,697	2,255	118	87	3.9%	73.7%	0.41%
Granville *	11,073	1,301	55	44	3.4%	80.0%	0.39%
Harnett *	12,998	1,554	66	48	3.1%	72.7%	0.37%
Johnston *	53,970	6,600	331	240	3.6%	72.5%	0.44%
Nash *	1,458	165	6	5	3.0%	83.3%	0.34%
Person *	13,122	1,595	78	59	3.7%	75.6%	0.41%
Total	651,765	78,651	5,508	4,194	5.3%	76.1%	0.64%

* County partially overlaps model region.

² 4,194 invited households completed the survey. Ten households were removed from the dataset during data cleaning. Of the remaining 4,184 households included in the delivered dataset, 4,169 have a home location within the current TRM model boundary provided to RSG. The 15 households with a home location outside the model boundary are flagged in the deliverable.



Details about the main survey, including survey methodology and results, are included in report Sections 2-9.

1.4 | SMARTPHONE GPS SURVEY OVERVIEW

The smartphone GPS sample for the 2016 HTS was conducted as a panel survey. All households in the smartphone GPS panel first participated completing the traditional one-day diary and were invited to participate a second time using rMove. Travel data were collected on participants' own smartphones using RSG's proprietary smartphone application, rMove. Households that met certain qualifications (listed in detail below) were invited to be part of the smartphone GPS panel. Recruit information was provided by households only one time, in part one of the traditional online survey (reducing participant burden).

Each GPS household was pre-assigned one of two possible three-day travel periods: Monday-Wednesday or Wednesday-Friday. For each household, at least one smartphone GPS travel day was the same weekday as the assigned travel day for the traditional survey (e.g. if a household participated in the traditional survey on a Monday, they were assigned Monday-Wednesday for GPS participation).

GPS panel households were recruited the week of April 11, 2016 and traveled the week of April 18, 2016 (week 7 of the main study). households were invited to participate if they met these criteria:

1. completed the traditional survey;
2. were sent their incentive prior to smartphone GPS recruitment;
3. all household adults 18+ reported having a qualifying iPhone or Android smartphone; and
4. the household agreed to be contacted for participation in future studies.

Utilizing a smartphone's GPS capabilities, rMove passively (i.e., as a background application running while the phone is on) collected location-based data, leveraging the smartphone's sensors to enable and disable logging based on a combination of GPS signal and detected movement, reducing both battery drain and concerns about internal storage. Following each trip, respondents were prompted to complete a short survey about the trip. RSG customized two drop-down answer lists within the rMove app to facilitate compatibility between data collected in the traditional approach and rMove for the 2016 HTS. These were the travel mode and trip purpose/activity lists. These same answer lists were used in the online travel diary and rMove, with slight modifications for rMove to render properly on smartphones (e.g., shortening of the answer descriptions to ensure all fit on the smartphone screen.).

Of the 1,515 households invited to participant in the smartphone GPS panel survey, 411 agreed to participate (27.1%) and 351 of those households completed the survey (85.4%). While 351 households completed the survey and received an incentive, fewer households (235) collected three complete days of data from all adult household members. The final completion criteria required that all household adults 18+ complete all trip surveys for all three assigned travel days. The smartphone GPS data were used to calculate trip rate correction factors for the traditional diary dataset. All complete GPS travel days were used for trip rate correction. More information about the smartphone GPS panel survey and trip rate correction can be found in Appendix K: Weighting Memo and Appendix L: Smartphone GPS Data Collection.

2.0 SURVEY DESIGN

2.1 | OVERVIEW

A household travel survey (HTS) seeks to obtain data that is representative of the demographic and travel behavior characteristics of regional households. Therefore, the survey must collect demographic information about households and individuals, as well as reported travel behavior. Collecting this information can help explain variations in travel patterns, ensure that the final survey responses are a reasonable representation of households and individuals throughout the region, and allow for weighting of the data as described in Section 8.0 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 an excel workbook containing a suggested list of variables for the survey, based on the variables collected in the 2006 Greater Triangle Household Travel Survey and on RSG’s household travel/activity survey experience. RSG then worked with NCSU-ITRE to finalize the survey data variables that would be collected, which were subsequently approved by the TAC.
- **Phase Two – Survey Development:** RSG provided NCSU-ITRE with a document including all survey pages, questions, and answers for review. NCSU-ITRE provided input on question wording, preferred response options, question order, and questionnaire logic. Revisions were implemented accordingly. RSG programmed the web-based survey instrument once this survey document was approved by NCSU-ITRE and the TAC.
- **Phase Three – Survey Design and Implementation:** NCSU-ITRE and the TAC had the opportunity to preview and comment on the survey prior to its execution. The RSG team programmed a web-based survey instrument as the primary data retrieval option for respondents, with telephone retrieval available as an option for respondents who prefer that method.

“Core” data elements are elements required for the transportation modeling and/or planning process. Most questions in this survey collected “core” data. An HTS can also include supplemental questions about commuting behaviors, travel preferences, and typical trip-making behavior over time; these are not required for the transportation modeling process, but can be helpful to the transportation planning process. RSG and NCSU-ITRE reviewed questions from the 2006 HTS and current regional transportation planning needs to determine which additional questions were most important.

Based on the core and supplemental information desired, the survey questionnaire was designed with three primary sections:

- Household questionnaire/recruit survey with information about the household, its members, and its vehicles.
- One-day travel diary (i.e., the Retrieval Survey) for every household member regardless of age.
- Person-level travel behavior and attitude questions (asked at the end of the Retrieval Survey).

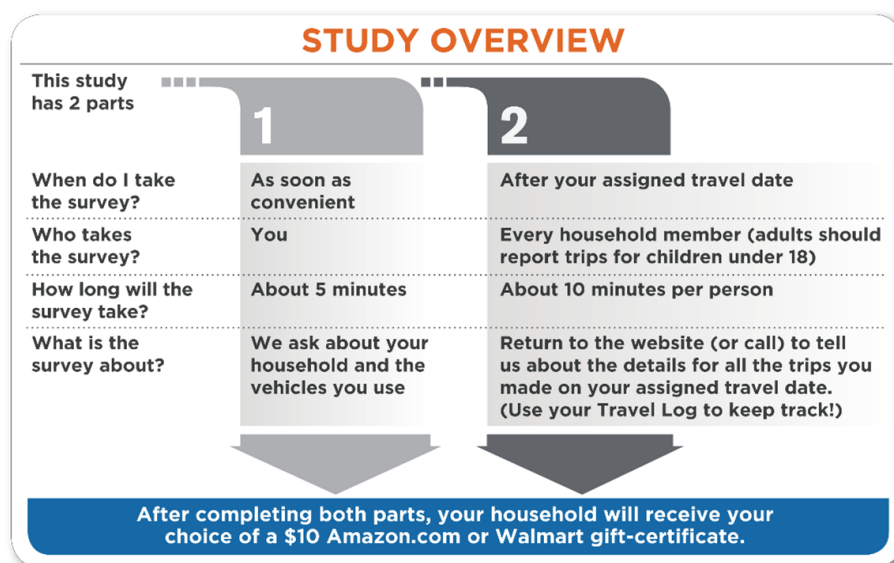
The online survey was implemented using RSG’s proprietary survey software, rSurvey, designed to ensure data consistency and minimize respondent burden. The rSurvey architecture includes rigorous Web 3.0



Protocol to protect data during and after collection (e.g., encryption of all data submitted via the Internet) to ensure proper consideration of all data privacy concerns and continuous “uptime” of all technology. ETC conducted all telephone activities for the survey for respondents preferring that method of contact using the same online survey tool to administer the survey over the phone.

Only one (adult) household member was required to complete the recruit survey. Once this section was complete, respondents were shown (or read) a survey dashboard with further instructions about logging their travel day trips and completing the retrieval survey. Household members returned to this dashboard after their travel date to access and complete the individual travel diaries. A household member was defined as anyone who lives in the same dwelling unit, including relatives, roommates, friends, or household help. The study overview figure shown in Figure 2 was provided to households in the FAQ section of the print materials provided to participating households.

FIGURE 2: STUDY OVERVIEW GRAPHIC



2.2 | HOUSEHOLD QUESTIONNAIRE (RECRUIT SURVEY)

An HTS typically consists of two sections: household questionnaire (i.e., recruit survey) and trip/activity diary (i.e., retrieval survey). The 2016 HTS also consisted of these two sections. The household questionnaire section contained questions about the demographic characteristics of the household, including the number of household members (adults and children), the number of licensed drivers, student status, the year/make/model/type (such as hybrid or other alternative fuel) of all vehicles in the household, and annual household income.

Respondents were also asked to identify household members by providing a unique name or initials along with their age, gender, relationship status, employment status, education status and highest level completed, ethnicity, and race. Other individual-level data, such as if the person has any mobility/disability issues that

impact their travel, personal income (i.e., workers' work-related income), smartphone ownership (used to identify potential rMove participants), and the number of jobs held by the person were also collected.

To conclude the household composition section, respondents were asked to provide contact information (either phone, email, or both, based on participant preference), as well as their home, work, and school addresses. Additionally, households were asked if they would be willing to participate in future survey efforts conducted by the agency. Households were able to complete the household composition section as soon as they received the pre-notice postcard, which included the survey link and a password that was unique to the household receiving it. The survey link and password were included on all printed survey materials.

The recruit survey was designed as a stand-alone survey that households could complete prior to their travel date, on their travel date, or immediately after their travel date. If completed after their travel date, households could then proceed directly to the retrieval survey to report their trips and typical travel patterns.

HOUSEHOLD DATA

Household data collected included the following variables:

- Household composition (number of members and relationships to householder).
- Household demographics (e.g., income).
- Current home location, type, and tenure.
- Household location.
- Number of household vehicles.
- Administrative data (e.g., contact information, incentive preferences, and willingness to participate in future studies).
- An optional comment box for households that wished to provide feedback on specific items.

PERSON DATA

The person-level details collected in the recruit survey were extensive and included:

- Person-level demographics (e.g., age, gender, race, ethnicity, disability, employment status, number of jobs held, student status, school details).
- Person-level details (e.g., education level, occupation, industry, employer commuter benefits, and driver's license ownership).
- Person-level locations (e.g., work locations (if employed) and school locations (if applicable)).
- Person-level behaviors used to dynamically design certain diary questions (e.g., use of paid parking).
- Person-level travel behavior questions to determine frequency of:
 - commuting to work,
 - paying to park (or free parking),
 - driving on toll roads,
 - utilizing car share,
 - riding transit,
 - biking, and
 - walking.



VEHICLE DATA

Respondents were asked how many motor vehicles (in working order) were in their household. All motor vehicles that the household regularly used, such as cars, trucks, SUVs, vans, RVs, and motorcycles (whether owned/making payments on, leased, or a company vehicle) were included. Uninspected/unregistered motor vehicles and vehicles such as ATVs, trailers, golf carts, or watercraft were excluded.

- Household vehicle details (e.g., make, model, year of vehicle, fuel type, year obtained vehicle, and toll transponder status).

2.3 | RETRIEVAL SURVEY (24-HOUR TRIP/ACTIVITY DIARY)

The retrieval survey included a 24-hour travel diary as well as person-level travel behavior and attitude questions. The diary collected trip-making behavior for every household member on their pre-assigned Monday, Tuesday, Wednesday, Thursday, or Friday travel date. The retrieval survey was made available to respondents starting on the day after their assigned travel date.

The first question was a proxy reporting question to determine whether the respondent was filling out his or her own survey, was present while another household member filled out the survey for them, or was not present while the survey was filled out for them by another household member. Next, the survey asked where a respondent started and ended their travel day (defined as 24 hours, beginning at 3 a.m. on the travel date). Respondents were then asked to provide a full list of all of the places they went during the travel date. If respondents did not go anywhere, they were asked to select one or more reasons why they did not travel. At the end of the trip roster page, a prompt question verified that respondents had reported all of their trips by listing the types of trips that are commonly forgotten and providing respondents the opportunity to add any trips they may have forgotten to report. Commonly under-reported trips include short trips (e.g., stops for gas or running a short errand on a lunch break) and loop trips (e.g., walking the dog or going for a run, etc.). There were specific instructions provided for loop trips, including a graphic that showed how those trips should be reported.

TRIP INFORMATION

The retrieval survey collected the following trip-related details for each person:

- The exact location of each place they went on their travel day (located by address or marked on a map)
- For the trip to each destination, respondents were asked:
 - when they traveled (when they started traveling and when they arrived); and
 - the main activity at their destination (e.g., go to work, personal errands, eat at a restaurant, drop-off, shopping, etc.).
- How they traveled (e.g., driving, carpooling, riding transit, walking, etc.).
- Whom they traveled with: either other household members, non-household members, or a combination of both (asked unless it was a drive alone trip).
- For driving trips, respondents were asked about:
 - vehicle used; and

- type and cost of parking location
- For carpool or vanpool trips (including both family-only and traditional carpool trips), respondents were asked:
 - where the carpool started; and
 - whether they were the driver or passenger
- For transit trips, respondents were asked:
 - how they got to and from the transit stop;
 - which specific transit systems and routes were used; and
 - methods of payment and cost of transit fare.
- For taxi and rideshare trips (e.g., Uber) respondents were asked:
 - the total cost of the fare for the trip.
- Toll road use and toll cost

Figure 3 shows the main survey activity code list, as shown on the 2016 HTS Travel Log for respondent reference.

FIGURE 3: MAIN SURVEY ACTIVITY CODES

ACTIVITY CODES		
<p>1 - At home activity, not working (for pay) or schooling</p> <p>2 - Working (for pay) at work or home</p> <p>3 - Work-related: delivering goods or services</p> <p>4 - Other work-related activity (meeting, visit, sales call, etc.)</p> <p>5 - Attend school/class</p> <p>6 - Other school-related activity</p>	<p>7 - Routine shopping (grocery, get gas, clothing, convenience store, household maintenance, etc.)</p> <p>8 - Shopping for major purchase /specialty item (appliances, electronics, new vehicle, major household repairs, etc.)</p> <p>9 - Dining out/take out/coffee (eat at restaurant, get take-out/fast-food)</p> <p>10 - Pick someone up</p> <p>11 - Drop someone off</p> <p>12 - Change type of transportation/Transfer to (take bus, take airplane, park a car or pick up a parked care if walk 2+ blocks, etc.)</p>	<p>13 - Household errands (bank/ATM, post office, dry cleaning, car services, etc.)</p> <p>14 - Personal business (visit government office, attorney, accountant, etc.)</p> <p>15 - Medical visit (doctor, dentist, etc.)</p> <p>16 - Recreation/entertainment (walk the dog, exercise/workout, go to a movie)</p> <p>17 - Social (visit friends/relatives)</p> <p>18 - Religious, civic, or volunteer</p> <p>19 - Other (not at home), specify: _____</p>

Finally, respondents could use a feature of rSurvey to easily “copy” trips across household members. When a respondent reported joint travel with another household member, that trip was then made available to household members who were reported on the trip to “copy” to their own travel diary. Subsequent household members had to verify that they took the joint trip. These members then skipped the geocoding and time reporting steps and were only asked about their activity at the trip destination (as it is reasonable that household members may have different activities at the same trip destination). For example, if a parent reported driving a child to school in his or her diary, he or she could copy that trip into the child’s diary instead of having to re-enter all of the details. The copy-trip functionality saved time, reduced respondent burden, and created built-in data consistency for intra-household travel.

Following the trip details for the day, respondents were asked for a few more details about their travel day, including:

- if the pre-assigned travel day was “typical” for each person (and, if not, reasons why) in their opinion;
- if they had telecommuted for part or all of their travel day instead of going to their workplace (if employed); and
- the number of packages or food deliveries to the household.



At the end of the retrieval survey, individuals were invited to provide open-ended comments about transportation issues in the region.

3.0 SURVEY BRANDING, MATERIALS AND COMMUNICATION

3.1 | PROGRAM BRANDING

The branding (i.e., study name, color scheme, and font selections) was developed by RSG with input from NCSU-ITRE, and was approved by the TAC. The project logo is shown in Figure 4.

FIGURE 4: TRIANGLE TRAVEL SURVEY BRANDING



3.2 | PRINT MATERIALS

Each of the 78,650 households invited to participate in the 2016 HTS received three mailings.

Pre-Notice Postcard: A pre-notice postcard was sent and arrived 7-10 days prior to the assigned travel date, notifying potential respondent households that a formal invitation would be arriving and that they would be offered an incentive upon completion of the study. Households were invited to log onto the website or call the toll-free number in order to learn more about the study and to fill out the household questionnaire.

Formal Invitation: A formal invitation to the survey arrived shortly after the pre-notice postcard. The cover letter (branded with the 2016 HTS banner (see Figure 4) letterhead) explained the study purpose, described the steps necessary to complete the study, and included logos and signatures from the four sponsor agencies. Other materials included in the invitation were travel logs and a sheet with FAQs.

Reminder Postcard: A reminder postcard arrived after the assigned travel date to encourage every household to complete the travel diary. It included the study phone number, website address, and participant login information.

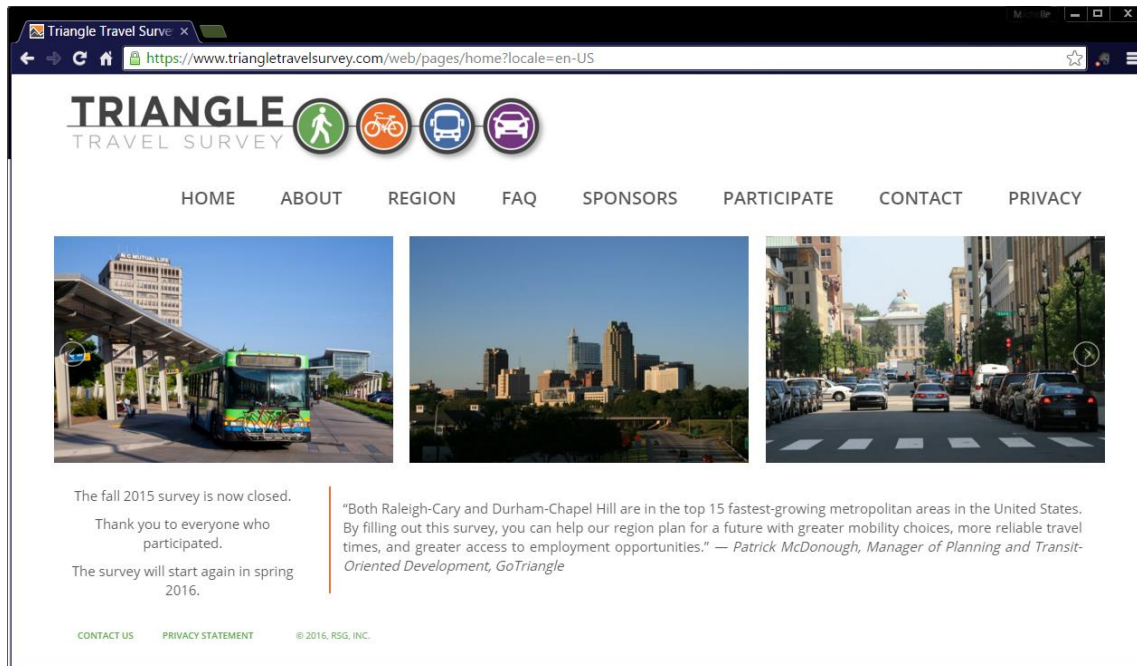
All survey materials are available for review in Appendix C.

3.3 | PROJECT WEBSITE

RSG developed the project website, which renders well on computers, tablets, and smartphones, and provides information about the project, such as FAQs, quotes of support, and contact information. The website served as the portal to the household questionnaire and the travel diary survey. Participants were provided with a unique password allowing them to access the survey from the website, and those who stopped midway through the survey could use their password to return later and resume the survey at the question they last answered. The "TriangleTravelSurvey.com" domain name was purchased by RSG for the project. The website home page is shown in

Figure 5.

FIGURE 5: TRIANGLE TRAVEL SURVEY “HOME” PAGE



3.4 | RECRUITMENT AND RETRIEVAL METHODS

All respondents were recruited by USPS postal mail. Households with landline phone numbers that did not self-recruit by web were called and invited to participate. Several print materials (see Section 3.2 and Appendix C) were mailed to each invited household, featuring consistent visual elements across all printed materials (and consistent with the online survey and website). The intended effect of this coordination was to connect all invitations, reminders, and other notices about the project, in order to maximize response rates. All aspects of this process were reviewed and refined by NCSU-ITRE and the TAC. All materials included a toll-free telephone number, the website URL, and the unique household password to use for participation.

ETC was responsible for all telephone communications for the 2016 HTS survey. ETC has highly-trained, long-serving staff to conduct objective, professional telephone surveys while capturing respondents' answers as fully as possible. Each telephone interviewer underwent training for the 2016 HTS, which included review of the online survey. RSG provided training documents, including the questionnaire (screen by screen), for reference, 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).

Telephone operators who assisted respondents in completing their survey, utilized the same web-based survey that web participants used. By administering the same survey both by phone and online, the answers of respondents that used the call in option were fully integrated with identical real-time validation as that of web respondents' answers. The telephone operators also had additional materials and information on hand, such as the project FAQs and the invitation letter, to inform their dialogue with household members. Both

English- and Spanish-speaking interviewers were available to assist callers. Ninety-two percent of recruited households completed the recruitment survey using the web. Among complete households, 89% completed the diary survey using the web survey and the remaining 11% completed by phone. All but nine households completing the survey online had their browser set to English. Six households had their browser set to Chinese, two Russian and one Japanese.

3.5 | PARTICIPANT REMINDERS

As part of the household questionnaire, respondents were asked to provide their preferred means of contact (by telephone or email). 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 who preferred email contact, reminders and follow-up efforts were conducted by email instead of by telephone. These efforts included:

- **Don't-Forget Email:** The day before the assigned travel date, a reminder email was sent to all households who had provided an email address.
- **Follow-up Email #1:** First thing on the morning after the assigned travel date, a reminder email was sent to all households who provided an email address and had not completed their follow-up survey.
- **Follow-up Email #2:** This reminder email was sent 48 hours after the assigned travel date and again on two subsequent occasions if the follow-up survey had not been completed.

All reminder emails provided general information about the project and the incentives available upon completion of the study. Additionally, the emails included an email 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.

3.6 | SURVEY INCENTIVES

A \$10 or \$20 gift card was offered to all households as incentive for completing the survey. The \$10 amount was printed on the invitation materials, but upon completion of the recruit survey, low-income (<\$25K) and/or large households (5 or more household members) were offered a \$20 gift card. Households could choose between Amazon or Walmart gift cards (sent via email or USPS mail). Alternatively, households could opt not to receive any gift for participation. Table 5 has the distribution of incentive types chosen by completed households. Most households preferred to receive their incentive via email (65.7%). Amazon was the more popular incentive type, chosen by 54.1 percent of households.

TABLE 5. HOUSEHOLDS BY INCENTIVE TYPE

Households by Incentive Type	Complete	Percent
Amazon (by email)	2,267	54.1%
Walmart (by email)	485	11.6%
Walmart (by mail)	1,372	32.7%
Neither	70	1.7%
Total	4,194	100%



4.0 SURVEY SAMPLING

A primary goal of the 2016 HTS was to collect travel behavior data from a representative set of households in the study region that will be used to update the regional transportation model. The sampling plan supported that goal by identifying key geographic, demographic, and travel characteristic segments and by determining sampling targets and response rates for these segments. The data collected is weighted along key factors, so that the final dataset more closely matches the characteristics of the regional population.

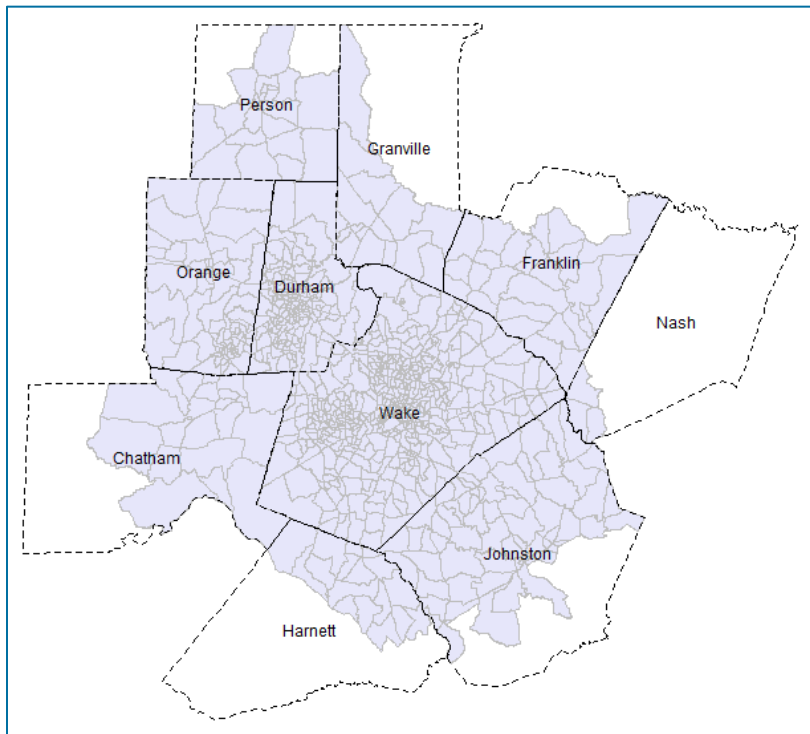
The sampling targets for certain segments were higher than those for the general population, to help collect sufficient data for households demonstrating certain behaviors (such as transit usage) and to ensure proper representation along various demographic factors relevant to modeling travel behavior. The sampling plan also identified population segments of particular interest to the region (such as university students). These segments were “targeted” to obtain a relatively larger proportion of these household types. Targeted oversampling is slightly different from “compensatory oversampling,” which is sometimes used (incorrectly) to indicate targeted oversampling. Compensatory oversampling involves inviting a higher percentage of certain households to come closer to achieving Census proportional demographics prior to any weighting. This is useful when certain households are known to respond at lower rates than other household types. Compensatory oversampling helps minimize differences between the study sample and the region’s total population. Targeted oversampling attempts 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 actually have at least one transit rider. In that case, transit households would be targeted for oversampling.

4.1 | SAMPLE FRAME AND SAMPLE AREA

The main study used an address-based sampling (ABS) 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 (proportional to population). Household mailing addresses were purchased from Marketing Systems Group (MSG), a firm that maintains the CDS file from the U.S. Postal Service (an electronic database of all mailing addresses). Survey invitation materials were then sent 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 at the time (2009-2013), including household income, typical commute mode, vehicle ownership, and other important factors. Figure 6 depicts the 2016 HTS study area and the associated block groups. The 2016 HTS study area included all of Durham, Orange, and Wake counties and portions of Chatham, Harnett, Johnston, Franklin, Granville, Nash, and Person counties. It does not include Vance and Lee counties, as the 2006 HTS did. A total of 857 unique block groups comprise the study area.

FIGURE 6: SURVEY SAMPLE AREA BLOCK GROUPS BY COUNTY



4.2 | SAMPLE METHODS AND RATES

The main study targeted 4,000 completed households. A conservative 5.5% response rate was estimated for households invited in the main study effort. This is higher than the assumed response rate for the pilot study, which was designed to target typically hard-to-reach households. It was estimated that hard-to-reach households would respond at a rate of 4%. To achieve a population-proportional sample (proportional to the distributions of households in the study region), this lower response rate from the pilot study was used to calculate the additional invitations needed for block groups identified as potential low-responders. This design helped ensure a sample that is close to population-proportional prior to any weighting. The main study considered the following household types for compensatory oversampling of block groups:

1. Low-income households (under \$25,000 per year)
2. Zero-vehicle households
3. Transit-user households (has household member that used transit on travel day)
4. Households with college or university students

To identify block groups for compensatory oversampling, these demographic variables were investigated in the 2009-2013 ACS five-year dataset. Block groups containing the top 5% of households that are most concentrated along these demographic dimensions were chosen. The number of block groups and the associated demographic proportions are summarized in Table 6.

For example, the top 5% of households on the low-income variable all have at least 50% of their households earning \$25K a year or less. The 50% threshold for the low-income variable was identified by first calculating

the concentration of households associated with the demographic variables (low-income in this example) for each block group. Block groups were then sorted by this concentration from high to low, and the top 5% of block groups were chosen to be oversampled (Table 7). This process was repeated for each of the four demographic variables that were investigated.

Block groups containing concentrations of college or university students were identified as those containing the top 5% of households with the most students per household – a slightly different measure, constructed with the available person-level ACS data. Block groups with an average of 0.56 or more college or university students per household were considered for oversampling.

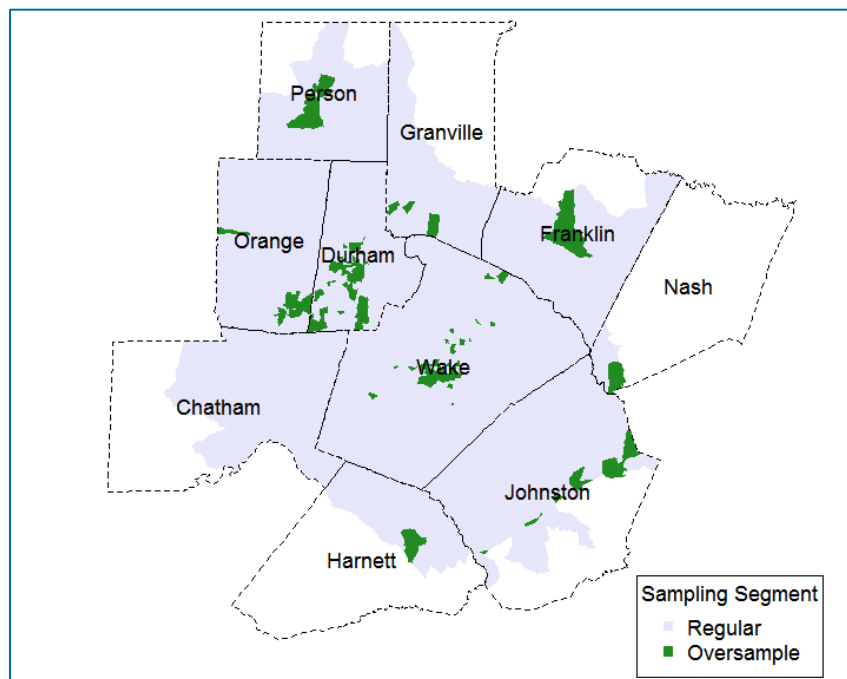
TABLE 6: BLOCK GROUPS FOR OVERSAMPLING

Household Type	Proportion Threshold	Number of Block Groups
Low-income	50%	68
Zero-vehicle	15%	69
Transit-user	7%	63
University Students	(0.56+ students per HH)	55

(155 unique)

These four demographic variables are positively correlated (i.e., some block groups qualified for oversampling for more than one reason), so only 155 unique block groups emerged as oversampling candidates from across all dimensions. These 155 unique block groups are plotted in Figure 7. Maps for each oversample type are available in the main survey sample plan.

FIGURE 7: BLOCK GROUPS FOR OVERSAMPLING



Block groups were then sorted by this concentration in decreasing order. Next, the cumulative proportion of HHs was calculated and used to identify the concentration threshold, and more directly, the block groups to be oversampled (Table 7). This process was repeated for each of the four demographic variables that were investigated.

TABLE 7: EXAMPLE IDENTIFICATION OF OVERSAMPLE BLOCK GROUPS

Block Group ID	Low-Income Concentration	Cumulative % of Households	
1	100%	0.1%	← Oversample
2	84%	0.2%	
:	:	:	
67	51%	4.9%	
68	50% (threshold)	5.0%	
69	49%	5.1%	
:	:	:	
856	1%	99.9%	
857	0%	100.0%	

It is important to note that while the Oversample segment block groups were selected because of their high concentrations of typically hard-to-reach households, it is not to say that similar households are not found in the Regular-segment block groups. The Oversample segment simply contains higher concentrations of these households.

The number of invitations needed was calculated based on the expected response rates (Table 8). These invitations were mailed in proportion to the population of the block groups for a given sampling segment. A population-proportional sample of 4,000 households corresponds to an overall sampling rate of 0.62% (the target completes divided by the total number of households).

TABLE 8: TARGET SAMPLE SIZES AND RATES

Sampling Segment	Block Groups	Households*	Target Completes	Response Rate (est)	Invitations Needed	Invitation Rate
Regular	702	557,408	3,475	5.5%	63,182	11.3%
Oversample	155	83,689	525	4.0%	13,125	15.7%
Total	857	641,097	4,000	5.25%	76,307	11.9%

* Source: ACS_2013_5YR_BG_37_NORTH_CAROLINA.gdb; Table: X00_COUNTS; Field: B00001e1

4.3 | DEMOGRAPHIC TARGETS

In addition to accounting for block groups with potentially low response rates, the main study sampling plan also imposed sample targets on household types of particular interest. At least 200 household completes were targeted from each of the following quota subgroups (possibly with overlap):

1. Low-income households (under \$25,000 per year)



2. Zero-vehicle households
3. Transit-user households (workers do not travel to work via auto)
4. Senior households (head of household³ age 65+)
5. University students (at least one household member attends college or university)

Senior households historically have some of the highest response rates, and it was assumed that there would be more than a sufficient number of completes to meet this quota. The expected number of completes in each of the remaining categories was calculated by applying the observed proportion of households (from the ACS data) to the number of target completes. Results for the demographic targets are shown in Sections 7.0 and 9.0.

4.4 | TRAVEL DATE ASSIGNMENT

The households invited to the one-day travel diary survey were assigned to one of 39 “travel dates” during a nine-week period, from February 29, 2016 through April 29, 2016. No travel dates were assigned during the week of spring break for public schools in Durham, Orange and Wake counties (e.g., Monday, March 28, 2016 through Friday, April 1, 2016). Additionally, Good Friday (Friday, March 25, 2016) was also excluded as an assigned travel date as it fell just prior to the vacation week (note that the other days that week, Monday, March 21, 2016 through Thursday, March 24, 2016 were assigned travel dates). All members of each household were asked to report all the trips they made (i.e., places they went) during their pre-assigned 24-hour travel date. All travel dates were assigned on a weekday (Monday – Friday). Travel dates were pre-assigned and invitations were evenly spread over eight weeks so that the recruitment and survey-retrieval processes could be easily managed.

³ Head of household was designated as the household member that completed the recruit survey unless that person was not employed, in which case the head of household was designated as the employed spouse or partner. If no household member was employed, the head of household defaulted to the household member that completed the recruit survey.

5.0 PUBLIC OUTREACH

5.1 | OBJECTIVES

The purpose of the public outreach was to encourage participation of invited households in the 2016 HTS. The strategies described in this plan supplement the pre-notice post card, survey invitation letter, and survey reminder postcard that were sent by postal mail directly to invited households.

The outreach plan:

- **Ensured that residents recognized and opened an invitation to participate in the survey** by informing potential participants that the study was happening and that it was legitimate, and by familiarizing the public with the survey brand.
- **Encouraged invited households to complete the survey** by instilling confidence that the study had benefits for their household, as well as for all residents of the region.
- **Minimized voluntary (uninvited) participation in the survey** by explaining the importance of collecting information from a random sample of households and by targeting most outreach to invited households rather than the general public.
- **Prepared local officials and information providers to answer questions** by providing transparent information to and inviting dialogue with local municipalities and regional entities.

5.2 | TARGET AUDIENCES

A primary component of the outreach plan was developing and maintaining a robust contact database of target audiences for outreach. The database included survey sponsors, news sources and media outlets serving the greater Triangle region, agencies and organizations whose mission has a nexus to transportation, and those organizations that serve hard-to-reach communities, including low-income, minority, and limited English proficiency (LEP) populations, as well as the elderly, students, and people with disabilities.

To identify contacts, regional and statewide contact databases from relevant prior project work were used as a starting point. These databases were updated to address gaps in outlying counties, and a draft database was circulated to the project team and partners for review. As the outreach plan was implemented, the database was updated to reflect requests to receive information about the survey. Careful attention was given to the point of contact within each organization. For example, when distributing information online, it was critical to include website or media administrators within an organization.

Contacts were categorized according to the methods used to reach them: (1) local officials who received a letter about the survey, (2) those who received public service announcements to disseminate by newspaper, television, or radio; (3) those who received information via Constant Contact; and (4) those who received posts to disseminate through their websites.

5.3 | METHODS

POSTAL MAIL

At the outset of the survey, a letter (see Appendix C) was prepared and distributed to a targeted distribution list including local officials and other information providers who were likely to receive questions from



households in the region about the study. The letter explained the purpose of the survey, how it was used, and the survey timing, and provided project team contact information and the URL for the survey website for further information. These targeted stakeholders included:

- North Carolina Department of Transportation
- County managers
- County planning directors and transportation planning leads
- Municipal managers
- Municipal planning directors and transportation planning leads
- Mayors
- Council members
- County commissioners
- Triangle J Council of Governments
- Transit agency managers
- Legislative representatives serving the region
- Communications directors at Duke University, NCSU, and UNC at Chapel Hill

PUBLIC SERVICE ANNOUNCEMENTS/PRESS RELEASES

Radio and television public service announcements (PSAs) (not paid advertisements) can serve as cost-efficient and effective methods for reaching a broad regional audience. Regional newspapers and radio and television stations were included in the contact database. PSAs were prepared and distributed to these contacts at the outset of the survey. The PSAs were designed to get local news providers excited about the survey and its purpose to encourage broadcast. Outreach to media contacts included:

- News and Observer
- Raleigh Chronicle
- Carolinian
- Cary News
- Eastern Wake News
- Garner Citizen News and Times
- La Conexion
- Que Pasa Raleigh
- Raleigh Downtowner
- Raleigh South Publications
- Southwest Wake News
- Triangle Business Journal
- Wake Weekly
- News 14 Carolina
- WRAL-TV (CBS)
- WNCN-TV (NBC)
- WTVD-TV (ABC)
- WUNC-TV (North Carolina Now)
- La Ley (radio)
- WUNC (radio)
- iHeartMedia (including five major local radio station)

A translated version of the survey invitation letter and FAQs documents were provided to media serving Spanish-speaking communities.

CONSTANT CONTACT NOTIFICATIONS

The project team developed and distributed digital project notifications using Constant Contact. Constant Contact provides an integrated mass mail method for managing contacts, allows contacts to forward notifications to their distribution lists, and provides the ability for contacts to subscribe or unsubscribe to

future notices. Notifications were formatted in a professional design consistent with all 2016 HTS media, including the project logo and website link. The notifications were sent to all media and targeted stakeholders, as well as broad interest organizations and service providers, such as bicycle and pedestrian groups, disability service providers, citizens' advisory councils, and others. The stakeholder list was developed and updated as described in the Target Audiences section of this plan.

WEBSITE POSTS

The 2016 HTS was supported and conducted in part through the existing project website (www.triangletravelsurvey.com). Details about the project website are available in Section 3.3. All information shared about the project directed contacts to the "News" tab of this website as the authoritative source of complete and current survey information. Notifications and messages were posted on the News tab of the website for use and distribution by visitors.

In addition to the project website, there were a number of other websites that are familiar sources of information for regional stakeholders. As part of the outreach plan, the team emailed administrators of these sites to encourage posting of survey information. Suggested posts were provided, including a link to www.triangletravelsurvey.com and the 2016 HTS logo. Transportation and county websites were targeted, including:

- North Carolina Department of Transportation (<http://www.ncdot.gov/>)
- Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (<http://www.dchcmpo.org/>)
- Capital Area Metropolitan Planning Organization (<http://www.campo-nc.us/>)
- GoTriangle (<http://www.gotriangle.org/>)
- GoSmart NC (<http://www.gosmartnc.org/>)
- Wake County (<http://www.wakegov.com/Pages/default.aspx>)
- Durham County (<http://dconc.gov/>)
- Orange County (<http://www.orangecountync.gov/>)
- Johnston County (<http://www.johnstonnc.com/>)
- Harnett County (<http://www.harnett.org/>)
- Chatham County (<http://www.chathamnc.org/>)
- Person County (<http://www.personcounty.net/>)
- Granville County (<http://www.granvillenc.govoffice2.com/>)
- Franklin County (<http://www.franklincountync.us/>)
- Nash County (<http://www.co.nash.nc.us/>)

MESSAGES AND TIMING

A survey initiation message and two survey reminders were distributed during the survey period.

SURVEY INITIATION

Two weeks prior to the distribution of the survey pre-notice postcard, a survey initiation message was distributed using all four of the strategies identified in the methods section. The survey initiation message was a critical component of the planned outreach. This was an opportunity to familiarize area households with the survey and what the pre-notice postcard mailed to invited households would look like. The main goal was to



ensure households recognized and paid attention to the pre-notice postcard and survey invitation letter if they received them in the mail. This message was provided with sufficient time for media to incorporate the message into their broadcasts, local officials and stakeholder interest organizations to prepare to share information with their constituents and members, and website administrators to post information on their sites. Key websites were monitored following the survey initiation message to ensure survey information was posted. Follow-up contact by telephone and email was made to key website administrators as necessary.

SURVEY REMINDERS

Two survey reminder messages were sent during the survey period using the Constant Contact notification and PSA methods. The purpose of these messages was to remind area households that the survey had been ongoing and to encourage those who had received an invitation to participate.

REVIEW AND IMPLEMENTATION SCHEDULE

The schedule for reviewing, approving, and implementing the outreach plan is presented below.

TABLE 9: PUBLIC OUTREACH ACTIVITIES AND TIMING

Activity	Timing
Submit outreach plan to ITRE	12/02/2015
ITRE comments on outreach plan	12/09/2015
TAC comments on outreach plan	12/18/2015
Revise outreach plan and develop draft contact database and survey initiation, survey reminder, and survey closing messages	01/11/2016
TAC meeting to discuss pilot results and comments on outreach plan, contact database, and messages	01/07-08/2016
ITRE/TAC comments on database and messages	01/19/2016
Revise messages	01/21/2016
Final proof of messages	01/26/2016
Distribute survey initiation message	01/28/2016
<i>Pre-notice postcard mailing</i>	<i>2/18/2016</i>
<i>Invitation letter mailing</i>	<i>2/23/2016</i>
<i>First travel date</i>	<i>02/29/2016</i>
Distribute first survey reminder message	03/23/2016
Distribute second survey reminder message	04/26/2016
<i>Last travel date</i>	<i>4/29/2016</i>

5.4 | EVALUATION

Outreach strategies were implemented during the survey period to help determine participation and outreach efficacy. During regularly-scheduled monthly meetings, the project team measured the following variables:

- The volume of invitation letters for the 2016 HTS
- The percentage of targeted stakeholders who have opened, clicked on the survey hyperlink within, or unsubscribed to Constant Contact notifications
- The number of identified websites that have posted information about the survey
- Summary reports of comments, questions, or complaints received through the survey email address or hotline number
- The survey response completion targets and achievement rates

Postal Mail. A total of 78,678 invitation letters were mailed and 7,304 were returned to sender, resulting in approximately 9.3% not reaching a targeted recipient. This return to sender percentage is consistent with other recent HTS across the U.S.

Public Service Announcements and Press Releases. PSAs were prepared and distributed to 21 regional newspapers and radio and television stations providing coverage in the Triangle region. Radio and television PSAs were used as cost-efficient and effective methods for reaching a broad regional audience.

Constant Contact Notifications. Constant Contact notifications were distributed to all media and targeted stakeholders, as well as broad interest organizations and service providers, such as bicycle and pedestrian groups, disability service providers, and citizens' advisory councils, to provide information and access to the survey. There were three waves of notifications sent to recipients in which the percentages of targeted stakeholders who had opened, clicked on the embedded hyperlink within, forwarded, or unsubscribed to Constant Contact notifications were recorded. The table on the following page shows these findings. A typical Constant Contact email campaign results in approximately 17.6% of emails opened; however, the rate throughout this survey period was notably higher with the average open rate, being above 30%.

The Constant Contact campaign led to the following:

- Emails sent to targeted stakeholders & website contacts (471), Spanish media contacts (4), and all other media contacts (32)
- Emails received by stakeholders & website contacts (453), Spanish media contacts (2), and all other media contacts (19)
- Percentage of received emails opened by stakeholders & website contacts (35.8%), Spanish media contacts (16.7%), and all other media contacts (37.7%)
- Percentage of embedded survey hyperlinks clicked from opened emails by stakeholders & website contacts (20.0%), * Spanish media contacts (0.0%), and all other media contacts (0.0%)
- Only one recipient unsubscribed throughout the survey period.



*The first and second Constant Contact notifications yielded a 31.5% and 27.3% hyperlink click rate (of opened emails), respectively. The third campaign yielded only a 1.6% hyperlink click rate from stakeholders & website contacts. This large drop in hyperlink activity, for the third notification, could be due to targeted stakeholders already being familiar with the survey link.

TABLE 10: PUBLIC OUTREACH RESULTS

Date Sent	Audience	Number Sent	Number Received* *Sent Less Bounces	Number Opened (% of Number Received)	Number of Hyperlink Clicks (% of Number Opened)
First Constant Contact Notification					
2/22/2016	Spanish Media Contacts	4	2	0 (0.0%)	0 (0.0%)
2/23/2016	Targeted Stakeholders & Website Contacts	486	458	181 (39.5%)	57 (31.5%)
3/1/2016	Media Contacts	39	28	9 (32.1%)	0 (0.0%)
Second Constant Contact Notification					
3/23/2016	Spanish Media Contacts	4	2	1 (50.0%)	0 (0.0%)
3/23/2016	Targeted Stakeholders & Website Contacts	458	441	165 (37.4%)	45 (27.3%)
3/23/2016	Media Contacts	29	27	10 (37.0%)	0 (0.0%)
Third Constant Contact Notification					
4/26/2016	Spanish Media Contacts	4	2	0 (0.0%)	0 (0.0%)
4/26/2016	Targeted Stakeholders & Website Contacts	470	453	138 (30.5%)	2 (1.6%)
4/26/2016	Media Contacts	28	3	11 (44.0%)	0 (0.0%)
Average Results of Constant Contact Notifications					
Average	Spanish Media Contacts	4	2	<1 (16.7%)	0 (0.0%)
Average	Targeted Stakeholders & Website Contacts	471	451	161 (35.8%)	35 (20.0%)
Average	Media Contacts	32	19	10 (37.7%)	0 (0.0%)

Website Posts. Throughout the survey period a number of websites that are familiar sources of information for regional stakeholders were targeted to post survey information. Suggested posts were provided, including a link to www.triangletravelsurvey.com and the 2016 HTS logo to website administrators. Fifteen transportation and county websites were targeted and the following actions resulted from the outreach effort:

- Town of Hillsborough: posted a notification on its website February 18, 2016
- Town of Knightdale: posted a notification on its website February 19, 2016
- News of Orange County: generated an online news article February 26, 2016
- DCHC-MPO: posted a notification on its Facebook page February 24, 2016
- Granville County: posted a notification on its website February 23, 2016
- GoTriangle: posted to its Facebook page March 9 and March 15, 2016
- NCDOT: issued an online news release March 7, 2016

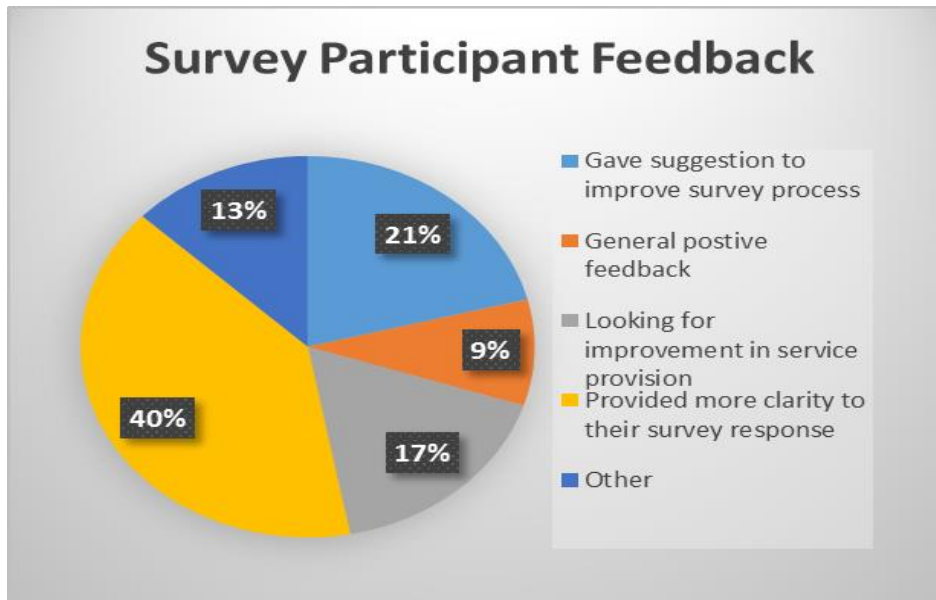
Survey Email Address and Hotline. Comments, questions, or complaints received through the survey, survey email address, or hotline number were tracked throughout the survey period. As stated, a total of 4,194 households participated in the survey. Overall, 813 comments, questions, and / or complaints were provided. The following table and pie chart demonstrate the types of feedback generated. Participant comments (excluding personally identifiable information) are included as part of the data deliverable.

TABLE 11: PARTICIPANT FEEDBACK

Type of Survey Participant Feedback	Number
Provided more clarity to their survey response	325
Suggestion to improve survey process	167
Looking for improvement in transportation system (service provision)	139
Other	109
General positive feedback	73
Total	813



FIGURE 8: PARTICIPANT FEEDBACK



The response of “provided more clarity to their survey response” typically took the form of a participant discussing route choice or their daily travel behavior in greater detail. Approximately 40 percent of the participant feedback provided more clarity into circumstances affecting their travel behavior.

The response type “suggestion to improve the survey process,” typically involved participants offering ideas or their desire to make the survey take less time, be less complex, offer faster survey question load time, or be able to better account for a typical day (not just the day the participant was asked to record his/her travel behavior). This response type accounted for 21 percent of the participant feedback.

The response type “looking for improvement in service provision,” indicated that the participant would have liked to see an enhancement of public transportation, pedestrian, or bicycle facilities. Typically, participants would like to see transit service closer to where they live, experience a higher frequency of service, see the addition of sidewalks or bike lanes in their community, or experience the implementation of a light rail or commuter rail service in the region. This response type accounted for 17 percent of the participant feedback.

The response type “other” captured any other comments, questions, or complaints from survey participants. Typically, participants expressed their disapproval for traffic congestion and some of these participants indicated that they would like to see public transportation options become available that would help them avoid it. A number of participants also expressed gratitude for current public transit provision. Additionally, other participants of this response type expressed their dislike of toll roads and paid parking. The “other” response type accounted for 13 percent of the participant feedback.

The response type “general positive feedback” encompassed positive feedback that was given regarding the survey process. This response type accounted for 9 percent of the participant feedback.

Survey Response Performance. All survey respondents were recruited via first-class mail. Those with phone numbers that did not self-recruit by web received a telephone invitation to participate. The project

team had a goal of reaching 4,000 completed household surveys. At the end of the study period, 4,194 households in 10 counties in the greater Triangle region completed the 2016 HTS. Thus, these results were considered a success because 105% of the completion target was achieved.

Of the households targeted for the survey, there was a goal of reaching special populations, as well. These included low-income and zero-vehicle households and households with one or more seniors, students or transit users. There was a goal to survey 200 households from each of these populations groups. Participation results are shown in the following table. Low-income, senior, and student household participation occurred well-above target levels. However, zero-vehicle (57% of target) and transit-user (98% of target) households did not meet participation target levels. Overall, households with special populations were highly represented throughout the survey process. The target of 1,000 special population households was met with the participation of 2,242 special population households.

TABLE 12: TARGETED HOUSEHOLD TYPES

Sample Type	Target	Actual	Percentage of Target
Low-income households	200	388	194%
Senior households	200	1,187	594%
Student households	200	358	179%
Transit households	200	196	98%
Zero-vehicle households	200	113	57%
Households (any type)	4,000	4,194	105%



6.0 DATA MONITORING, PROCESSING AND PREPARATION

6.1 | DATABASE SETUP AND DATA MONITORING

The steps for data preparation, quality control, and data deliverables for the 2016 HTS are shown in Table 13. This table includes the primary tasks conducted pre-launch, during data collection, and post data collection. The details in this table are provided in response to an NCSU-ITRE request for more information about the data preparation and quality control steps.

TABLE 13: DATA PREPARATION AND QUALITY CONTROL BY SURVEY PHASE

Phase	Task/Product
Pre-launch	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 for recruit survey on servers
	Upload survey to production/request servers
	Spot checks on servers
	Update SQL/SPSS syntax on servers
	RECRUIT LAUNCH (start monitoring responses)
	Run automated testing procedure on retrieval survey
	Write-out testing/review for retrieval on servers
During data collection	Monitor data on servers
	Monitor errors, dropouts, overall response rates
	Monitor pilot comments (email and in survey), log, and categorize
	RETRIEVAL LAUNCH (check for diary responses)
	Confirm survey closure
	Clean/process data
Post data collection	Identify/flag data corrections/derivations
	Export final datasets
	Weight datasets

Phase	Task/Product
	Process rMove GPS data
	Document data cleaning/create dataset guide, codebook
	Write final report, including appendices
	Deliver final datasets and documentation

6.2 | QUALITY CONTROL AND REVIEW

Data write-out testing was conducted on throughout data collection. The primary steps are shown below.

1. The primary write-out review task involved reviewing frequency tables for all variables to confirm that each variable has expected inputs (based on survey logic/branching). This involved developing the “data collection” SQL views and SPSS labels and tabulations syntax.
2. Checks for consistency and branching. Did all the variables have the correct number of responses (based on survey logic)?
 - a. Were there any values outside the allowable range?
 - b. Were there responses for all the categories?
 - c. Comparing sums/counts across tables: for example, did the sum of the household size variable match the number of person records?
 - d. Reviewing the “dropout” page frequency to confirm that the survey did not stick on a particular page.
3. Conducting “spot checks” to confirm that all the metadata variables were present and recording data, confirming that text strings were not truncated and confirming that values were cleared or overwritten if a survey response is changed.

6.3 | 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 must be reviewed and cleaned to assure the quality of the final data. This includes reviewing response frequencies for consistency, mapping location data, flagging, correcting or excluding records with survey errors, and deriving key variables for downstream data uses. This section discusses the data preparation process and summarizes steps taken to prepare the final datasets.

EXCLUSION CRITERIA

Of the 78,678 households invited to participate in the main study, 4,194 completed both the recruit and diary/trip reporting portions of the study in the spring of 2016. Frequency distributions for all of the categorical variables were reviewed to confirm that the correct number of responses were recorded and that the response distributions generally fell within expected ranges. These checks helped identify a small number of issues requiring correction. These data corrections and exclusions included the following:



- Fourteen households were found to have left the survey on the last page and did not submit their responses. The data from these households were otherwise complete and thus are included in the final count.
- Nine households were missing the geographic information for at least one of the key locations recorded by the survey: home (1), school (1), primary work (1), or a trip end (6). While this location information was not recorded in the database, it appears to still have been available to respondents while taking the survey. Thus, their survey experience appears to have been unaffected and completed their survey without getting “stuck”. These household were removed from the dataset.
- One household was missing the details of their two household vehicles and was removed from the final dataset.

Possible reasons for these failures include: 1) the wide range of devices, operating systems, and browsers used by participants, and 2) unanticipated participant browser behavior. The final dataset contains 4,184 households. Fifteen households had a home address outside of the model region. These households were included in the dataset, but were excluded from certain analyses and tabulations, including weighting.

GEOGRAPHIC DATA CHECKS

Geographic data checks included reviewing the address and coordinate data recorded passively by the survey program during data collection. Additionally, during data collection, the rSurvey program used the Google Maps API Distance Matrix Service to estimate distance and travel time between a trip’s origin and destination points. These estimates indicate the distance and duration of a trip using “standard driving directions”⁴ during “free flow” travel conditions and allow comparisons to be made to the self-reported trip durations. They could also be used for future trip validation to detect trip records with potential issues. All but a few trips returned Google distance and time estimates, with the exceptions typically being trips that are not made on public roads (e.g., airplane trips, off-road trips, or trips on private roads).

DERIVED AND CALCULATED VARIABLES

In addition to the core variables reported by respondents, a set of derived variables are necessary for downstream data weighting and analysis. Similar quality checks were conducted on the derived and added variables as were conducted on the core data. Examples of these derived variables include:

- The number of adults in each household;
- The number of workers in each household;
- The number of children in each household;
- The age range of all persons;
- Time period (i.e., AM Peak, PM Peak, Midday and Night);
- The number of trips reported per household; and
- The number of household members traveled with.

These and other derived variables aid with data clarity and aim to make analysis more efficient by merging disaggregate responses from detailed categories or multiple survey questions into simpler variables. All

⁴ <https://developers.google.com/maps/documentation/javascript/distancematrix>

derived variables were labeled as such in the data codebook (Appendix H) and in the main survey tabulations (Appendices I & J).

Several geographic variables were calculated indicating a household's location at several levels of granularity. Household geographic variables are not available for the 15 households that are located outside of the model region.

- *home_loc_fips* 5-digit county FIPS (Federal Information Processing Standard)
- *home_loc_puma* 5-digit PUMA (Public Use Microdata Area)
- *home_loc_tract* 6-digit Census tract
- *home_loc_bg* 12-digit Census block group
- *home_loc_taz* TAZ of the TRM

Note: The Census tract identifiers (i.e. "020400") only are unique within a state and county.

DATA FLAGS

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

- *home_loc_region* indicates whether a household is outside of the model region
- *user_language* the ISO code indicating the respondents' browser language settings (e.g., "en-us" for United States English)
- *user_ismobiledevice* a binary flag indicating whether respondents completed the survey on a mobile device (based on device operating system and screen size)
- *user_callcenter* a binary flag indicating whether respondents completed the survey via the call center
- *prepop* variable is a binary flag indicating whether trip details were copied from a previously reported trip
- *hmember[N]* variables are binary flags indicating whether household person *N* (i.e. the *personNum* variable) was present on the trip

A small subset of trip records (approx. 2%) had trip distances of exactly zero miles and were flagged for further inspection (*trip_flag*). It is left to the user to determine the appropriate course of action for these records. Generally, these flagged trips fall into one of three categories:

- Loop trips (e.g., a walk around the block that wasn't split into two trips)
- False trips (e.g., trips that don't appear to go anywhere, such as a user erroneously reporting "Then I went home" as a destination prior to the "Home" destination at the end of the day)
- Very short, but legitimate trips (e.g., a walk to a neighbor's house)

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.
- The questionnaire contained logic to handle the case where a transit trip was made using one of GoTriangle, GoRaleigh, GoDurham, or C-Tran, and one of Chatham Transit Network or Orange Public Transportation. It is possible for riders to use a combination of payment methods (transit pass/stored-value card and cash/tickets) and so a question was asked to capture the additional cost, if applicable. No respondents reported making such a trip, so this variable was removed.

INCOME IMPUTATION

While all respondents were asked about their household income, these questions permitted a “prefer not to answer” selection, leaving gaps in the data or cases where respondents chose fairly broad income categories (i.e., “\$100K+”) in some cases. Due to the importance of household income to weighting and modeling, household income was imputed using a model based upon the remaining survey data. This section offers a brief overview of the model used to impute those household income values. For more detail, please refer to the data weighting memo provided in Appendix K.

The basic steps of imputing income are to assess which independent variables are the best predictors of household income, develop and estimate a model, and apply that model to the dataset.

Independent Variables Used in the Household Income Estimation Model

The most important variables for imputing income reflect the earnings potential for household adults.

- Adults were classified by four employment types: full-time worker, part-time worker, retired, and other non-working adults.
- Workers were further sub-classified by highest level of education reached – graduate degree, undergraduate degree, or “no degree,” which in this case means lower than a Bachelor’s degree.
- The number of adults in the household for each employment type and education level was the combined metric used for modeling (i.e., “number of full-time workers with undergrad degree”).
- Race/ethnicity was used, with three variables for the number of adults in the household who classified themselves as Hispanic, Black (non-Hispanic), and Asian (non-Hispanic).
- Housing type and housing ownership type were used, with dummy variables for renters and those living in single-family, detached houses.
- Finally, the percentages of households in the high and low-income categories for the respective block groups were used, as the lowest and highest income households are often clustered geographically.

Dependent Variable for the Household Income Estimation Model

The dependent variable is the household’s self-reported income, grouped into the same six categories used for weighting (\$0-25K, \$25-50K, \$50-75K, \$75-100K, \$100-150K, and \$150K+).

Model Estimation

A multinomial logit (MNL) model was used to estimate income category. The model estimation was done in SPSS and the model fit was good for models of this type (Cox and Snell pseudo R-square = 0.521).

The general results of the model were:

- The number of full-time workers shows the strongest effect, with increasing probability of being in the higher income group as there are more full-time workers—particularly those with college degrees.
- The effects of part-time workers on higher income groups are less, although there is more variation with education level.
- The number of retired adults shows a similar effect as part-time workers, presumably due to income from pensions and social security.
- The race/ethnicity variables all show negative effects. The effect is strongest for Hispanic adults, and least strong for Asian adults.
- Renting households are significantly less likely to be in the higher income groups, while those with single-family, detached houses (the majority of the households in the sample) are somewhat more likely to be in the higher income groups.
- Those living in block groups with higher fractions of households with incomes less than \$25K are less likely to be in any of the higher income groups. Those in block groups with high fractions of households with incomes above \$100K are more likely to be in the higher income groups. The strongest clustering effect is for the \$150K-plus alternative.

Model Application for Imputing Income

There are two main ways to predict income with a discrete choice model: (a) select the income group that has the highest probability for each household, or (b) use a Monte Carlo simulation method, randomly selecting an income category using the model choice probabilities for each category. While the highest probability method does a better job at predicting the actual income groups reported by the respondents, the Monte Carlo method is more consistent with the assumptions underlying the MNL model and is less likely to be biased. Therefore, the Monte Carlo method results were used to impute the income group used in weighting for the missing cases, as shown in Table 14.

TABLE 14: FINAL (IMPUTED) INCOME CATEGORIES VERSUS REPORTED INCOME

		HH INCOME GROUP USED FOR WEIGHTING						Total
		\$25,000	\$25,000- \$49,999	\$50,000- \$74,999	\$75,000- \$99,999	\$100,000- \$149,999	\$150,000 +	
REPORTED HH INCOME GROUP	Under \$25,000	385	0	0	0	0	0	385
	\$25,000-\$49,999	0	675	0	0	0	0	675
	\$50,000-\$74,999	0	0	697	0	0	0	697
	\$75,000-\$99,999	0	0	0	580	0	0	580
	\$100,000- \$149,999	0	0	0	0	725	0	725
	\$150,000+	0	0	0	0	0	519	519
	Missing	36	80	107	112	154	99	588
	Total	421	755	804	692	879	618	4,169

7.0 SURVEY RESULTS

The goal for the main survey was to collect data from 4,000 households. All results in this section are for unweighted data. Table 15 shows the sample sizes and sample rates for delivered households in the model region by sample type. For the 2016 HTS, a “complete” household was defined as one in which all eligible household members answered every single data element (every question) in the survey, with the exception of household income, race, ethnicity, and disability, for which refusals (“prefer not to answer” selection) were allowed. Households with partial (incomplete) data were not included toward sample size goals, and are not included in the data deliverable. There were ten households removed from the dataset during cleaning, leaving 4,184 households in the deliverable. Overall, the sample size exceeded the goal. The overall response rate of 5.48% (completed/invited) is consistent with the sample planning estimates. Table 16 shows sample sizes and sample rates by county. The tables in this section include information on response by sample segment, county, and various demographic variables. Several tables include ACS data. ACS data in this report are the five-year 2010-2014 data for Census block groups in the model region only. Since only block groups in the model region are included, county-level ACS counts for counties that are only partially contained in the model region are lower than the total counts for those counties. Many of the data shown in this section are repeated in Section 9.0 Weighted Survey Results, with the weighted and ACS data included as well.

7.1 | RESPONSE SUMMARY

TABLE 15: FINAL SAMPLE SIZES AND RATES

Sample Type	Survey Count	Survey Percent	ACS Count	ACS Percent	Sample Rate (%)	Invites	Response Rate (%)
Regular sample	3,608	86.2%	567,563	87.1%	0.64%	63,182	5.71%
Oversample	576	13.8%	84,202	12.9%	0.68%	13,125	4.39%
Total	4,184	100.0%	651,765	100%	0.64%	76,307	5.48%

Note: Sample rate = Survey Count / ACS Count.

TABLE 16: FINAL SAMPLE SIZE AND SAMPLE RATES BY COUNTY

County	Survey Count	Survey Percent	ACS Count	ACS Percent	Sample Rate (%)
Durham	688	16.5%	113,564	17.4%	0.61%
Orange	444	10.7%	51,419	7.9%	0.86%
Wake	2,417	58.0%	355,647	54.6%	0.68%
Chatham*	148	3.6%	17,817	2.7%	0.83%
Franklin*	85	2.0%	20,697	3.2%	0.41%
Granville*	43	1.0%	11,073	1.7%	0.39%
Harnett*	48	1.2%	12,998	2.0%	0.37%
Johnston*	237	5.7%	53,970	8.3%	0.44%
Nash*	5	0.1%	1,458	0.2%	0.34%
Person*	54	1.3%	13,122	2.0%	0.41%
Total	4,169	100.0%	651,765	100.0%	0.64%

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



Table 17 shows conversion rates (completed household / recruited households) by sample segment. More information on sample segments is available in Section 4.0 Survey Sampling.

TABLE 17: CONVERSION RATES BY TARGET SEGMENT

Segment Type	Target	Recruited	Completed	Conversion Rate (%)
Low-Income HHs (<\$25k)	200	494	388	78.5%
Zero-Vehicle HHs	200	154	113	73.4%
Senior HHs	200	1,484	1,187	80.0%
Student HHs	200	519	358	69.0%
Transit Trip HHs	200	200	196	98.0%

Table 18 shows the final count for survey responses at the household, person, and trip-level.

TABLE 18: RESPONSE SUMMARY (HOUSEHOLD, PERSON, VEHICLE, AND TRIP)

Households	Vehicles	Persons	Trips
4,184	7,684	9,232	38,267

7.2 | HOUSEHOLD RESULTS

TABLE 19: HOUSEHOLD PARTICIPATION BY DAY OF WEEK

Day of Week	Count	Percent
Monday	896	21.4%
Tuesday	865	20.7%
Wednesday	859	20.5%
Thursday	829	19.8%
Friday	735	17.6%
Total	4,184	100.0%

TABLE 20: HOUSEHOLD SIZE

Household Size	Survey Count	Survey Percent	ACS Count	ACS %
1 person	1,189	28.4%	176,852	27.1%
2 people	1,811	43.3%	219,566	33.7%
3 people	575	13.7%	108,238	16.6%
4 or more people	609	14.6%	147,109	22.6%
Total	4,184	100.0%	651,765	100.0%

TABLE 21: NUMBER OF HOUSEHOLD VEHICLES

Household Vehicles	Survey Count	Survey Percent	ACS Count	ACS %
0 vehicles	113	2.7%	36,200	5.6%
1 vehicle	1,400	33.5%	212,789	32.6%
2 vehicles	1,948	46.6%	267,972	41.1%
3 or more vehicles	723	17.3%	134,804	20.7%
Total	4,184	100.0%	651,765	100.0%

TABLE 22: HOUSEHOLD INCOME

Income	Survey Count	Survey Percent	Valid %	ACS Count	ACS %
Under \$25,000	386	9.2%	10.4%	123,830	19.0%
\$25,000-\$49,999	680	16.3%	18.3%	151,019	23.2%
\$50,000-\$74,999	699	16.7%	18.8%	115,813	17.8%
\$75,000-\$99,999	583	13.9%	15.7%	83,272	12.8%
\$100,000 or more	1,362	32.6%	36.7%	177,831	27.3%
Valid total	3,710	88.7%	100.0%	651,765	100.0%
Prefer not to answer	474	11.3%	0.0%	n/a	n/a
Total	4,184	100.0%	100.0%	651,765	100.0%

TABLE 23: AGE DISTRIBUTION

Age	Survey Count	Survey Percent	ACS Count	ACS %
< 16 years (ACS < 15 years)	1,668	18.1%	355,699	20.5%
16-24 years (ACS 15-24)	535	5.8%	245,580	14.2%
25-34 years	1,241	13.4%	252,701	14.6%
35-44 years	1,300	14.1%	261,317	15.1%
45-54 years	1,315	14.2%	246,805	14.2%
55-64 years	1,458	15.8%	191,638	11.1%
65+ years	1,715	18.6%	180,424	10.4%
Total	9,232	100.0%	1,734,164	100.0%

TABLE 24: GENDER DISTRIBUTION

Gender	Survey Count	Survey Percent	ACS Count	ACS %
Male	4,336	47.0%	843,099	48.6%
Female	4,896	53.0%	891,065	51.4%
Total	9,232	100.0%	1,734,164	100.0%



TABLE 25: RACE DISTRIBUTION

Race	Survey Count	Survey Percent	Valid %	ACS Count	ACS %
Asian	323	4.3%	4.6%	80,477	4.6%
Black or African American	651	8.6%	9.2%	385,009	22.2%
White	5,902	78.0%	83.4%	1,165,201	67.2%
Other (e.g., American Indian, Native Hawaiian, etc.)	88	1.2%	1.2%	61,037	3.5%
Two or more races	115	1.5%	1.6%	42,440	2.4%
Valid total	7,079	93.6%	100.0%	1,734,164	100.0%
Prefer not to answer	485	6.4%	0.0%	n/a	n/a
Total	7,564	100.0%	100.0%	1,734,164	100.0%

7.3 | TRIP RATES AND TRIP DETAILS

The tables in this section show trip rates by county and by various demographic criteria, and summarize the trip data collected by the survey. All trip rates in this section are for unweighted data.

TABLE 26: HOUSEHOLD AND PERSON TRIP RATES

	Survey Count	Trip Count	Daily Trip Rate
Household	4,184	38,267	9.15
Person	9,232	38,267	4.15

TABLE 27: HOUSEHOLD TRIP RATE BY COUNTY

County	Household Count	Trip Count	Daily Trip Rate
Durham	688	6,065	8.82
Orange	444	3,905	8.80
Wake	2,417	22,959	9.50
Chatham*	148	1,261	8.52
Franklin*	85	683	8.04
Granville*	43	423	9.84
Harnett*	48	414	8.63
Johnston*	237	2,037	8.59
Nash*	5	43	8.60
Person*	54	380	7.04
Total	4,169	38,170	9.16

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

TABLE 28: HOUSEHOLD TRIP RATE BY HOUSEHOLD SIZE

Household Size	Survey Count	Trip Count	Daily Trip Rate
1 person	1,189	5,954	5.01
2 people	1,811	15,337	8.47
3 people	575	6,428	11.18
4 or more people	609	10,548	17.32
Total	4,184	38,267	9.15

TABLE 29: TRIP RATE BY NUMBER OF HOUSEHOLD VEHICLES

Household Vehicles	Survey Count	Trip Count	Daily Trip Rate
0 vehicles	113	500	4.42
1 vehicle	1,400	9,146	6.53
2 vehicles	1,948	20,803	10.68
3 or more vehicles	723	7,818	10.81
Total	4,184	38,267	9.15

TABLE 30: PERSON-LEVEL TRIP RATE BY COUNTY

County	Trip Count	Daily Trip Rate
Durham	6,065	4.33
Orange	3,905	4.22
Wake	22,959	4.18
Chatham*	1,261	3.86
Franklin*	683	3.90
Granville*	423	3.95
Harnett*	414	4.27
Johnston*	2,037	3.68
Nash*	43	3.58
Person*	380	3.30
Total	38,170	4.15

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

TABLE 31: TRIP RATE BY GENDER

Gender	Survey Count	Trip Count	Daily Trip Rate
Male	4,336	17,396	4.01
Female	4,896	20,871	4.26
Total	9,232	38,267	4.15



TABLE 32: TRIP RATE BY AGE

Age	Survey Count	Trip Count	Daily Trip Rate
< 16 years	1,668	5,526	3.31
16-24 years	535	1,771	3.31
25-34 years	1,241	5,202	4.19
35-44 years	1,300	5,981	4.60
45-54 years	1,315	6,043	4.60
55-64 years	1,458	6,325	4.34
65+ years	1,715	7,419	4.33
Total	9,232	38,267	4.15

TABLE 33: TRIP RATE BY RACE

Race	Survey Count	Trip Count	Daily Trip Rate
Asian	323	1,078	3.34
Black or African American	651	2,688	4.13
White	5,902	26,215	4.44
Other (e.g. American Indian, Native Hawaiian, etc.)	88	319	3.63
Two or more races	115	464	4.03
Prefer not to answer	485	1,977	4.08
Total	7,564	32,741	4.33

TABLE 34: TRIP RATE BY DRIVERS LICENSURE

Has Driver License	Survey Count	Trip Count	Daily Trip Rate
Yes, driver's license	7,145	31,599	4.42
Yes, learner's permit	97	293	3.02
No	1,990	6,375	3.20
Total	9,232	38,267	4.15

TABLE 35: TRIP RATE BY UNIVERSITY STUDENT STATUS (18+)

University Student	Survey Count	Trip Count	Daily Trip Rate
No, Not University Student	6,888	36,584	4.15
Yes, University Student	529	1,683	4.08
Total	7,417	38,267	4.15

TABLE 36: TRIP RATE BY WORKER STATUS (16+)

Worker Status	Survey Count	Trip Count	Daily Trip Rate
No, Not Worker	2,855	17,252	3.81
Yes, Worker	4,709	21,015	4.46
Total	7,564	38,267	4.15

TABLE 37: NUMBER OF TRIPS BY MODE

Travel Mode	Count	Percent
Vehicle in household (or motorcycle/moped)	30,012	78.4%
Walk/jog/wheelchair	4,941	12.9%
Other vehicle (e.g., rental, friend's car, carshare, taxi, work car)	1,546	4.0%
Any bus (e.g., public bus, school/university bus, paratransit)	1,254	3.3%
Bicycle	378	1.0%
Other	136	.4%
Total	38,267	100.0%

TABLE 38: NUMBER OF TRIPS BY DESTINATION ACTIVITY TYPE

Activity Type	Count	Percent
At home activity, not working (for pay) or schooling	12,560	32.8%
Routine shopping (grocery, get gas, clothing, convenience store, household maintenance, etc.)	4,911	12.8%
Working (for pay) at work or home	4,763	12.4%
Recreation/entertainment (walk the dog, exercise/workout, go to a movie)	2,897	7.6%
Dining out/take-out/coffee (eat at restaurant, get take-out/fast-food)	2,414	6.3%
Attend school/class	2,037	5.3%
Drop someone off	1,146	3.0%
Pick someone up	1,097	2.9%
Household errands (bank/ATM, post office, dry cleaning, car services, etc.)	992	2.6%
Other work-related activity (meeting, visit, sale call, etc.)	710	1.9%
Social (visit friends/relatives)	680	1.8%
Medical visit (doctor, dentist, etc.)	668	1.7%
Other (not at home)	664	1.7%
Other school-related activity	657	1.7%
Change type of transportation/Transfer to (take bus, airplane, park car or pickup parked car if walk 2+ blocks, etc.)	621	1.6%
Religious, civic, or volunteer	520	1.4%
Personal business (visit government office, attorney, accountant, etc.)	377	1.0%
Work-related: delivering goods or services	286	.7%
Shopping for major purchase/specialty item (appliance, electronics, new vehicle, major household repairs, etc.)	267	.7%
Total	38,267	100.0%



TABLE 39: TYPICAL MODE TO WORK, EMPLOYED/VOLUNTEER ADULTS

Reported Travel Mode	Count	Percent
Drive alone	3,509	85.8%
Carpool with only family/household member(s)	261	6.4%
Bus (public transit)	112	2.7%
Bicycle	61	1.5%
Walk/jog/wheelchair	56	1.4%
Carpool with at least one person not in household	51	1.2%
Other	18	.4%
Motorcycle/moped/scooter	9	.2%
Vanpool	8	.2%
Taxi or other hired car service (e.g., Lyft, Uber)	5	.1%
Private shuttle bus	1	.0%
Paratransit	0	0.0%
Train (any rail, subway, monorail)	0	0.0%
Express school bus service	0	0.0%
School bus	0	0.0%
Total	4,091	100.0%

7.4 | GEOGRAPHIC COVERAGE

The maps in this section show the geographic extent of home, work, and school locations.

FIGURE 9: PRIMARY HOME LOCATIONS: COMPLETE HOUSHOLDS

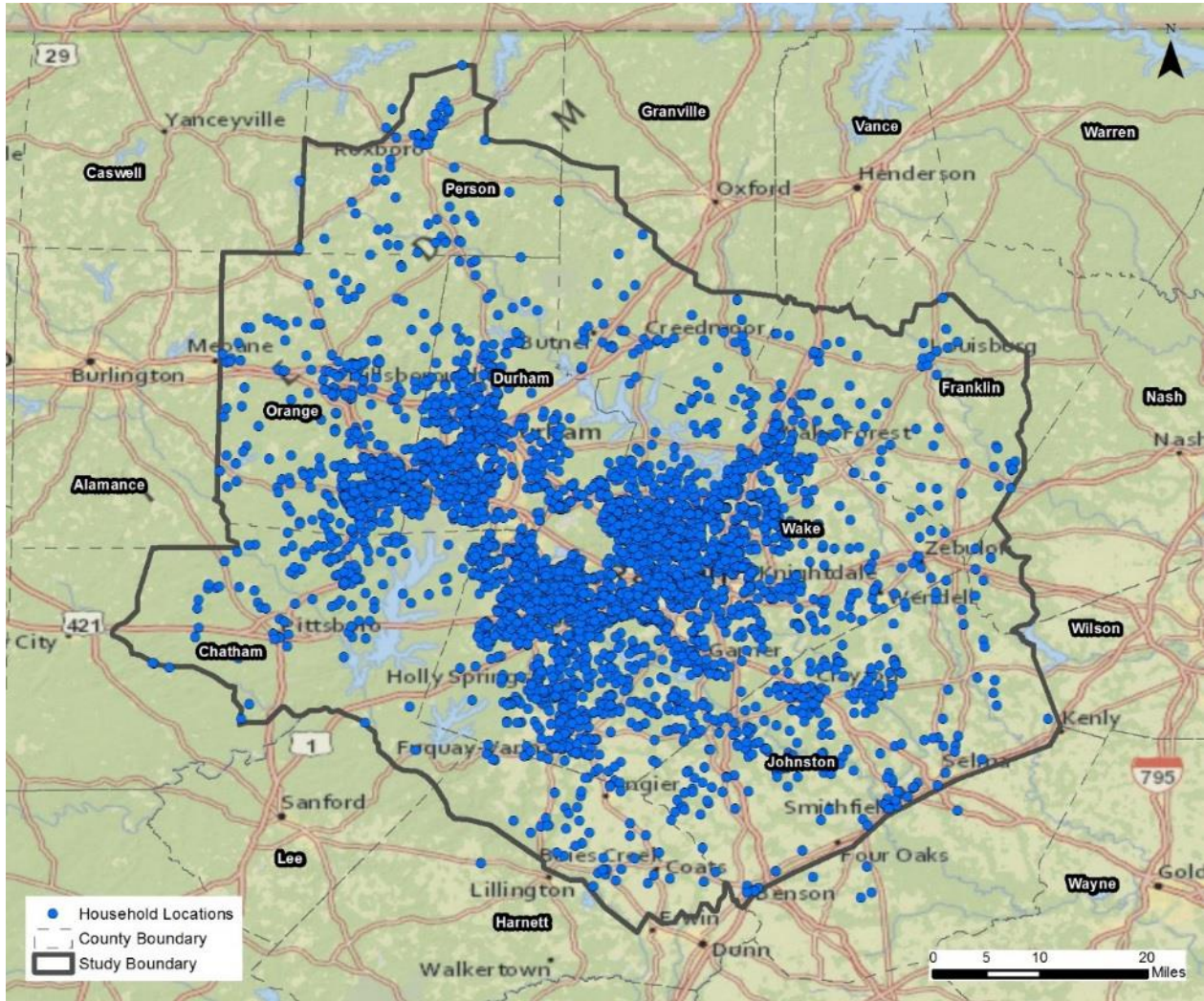


FIGURE 10: PRIMARY WORK LOCATIONS FOR WORKERS IN COMPLETE HOUSEHOLDS

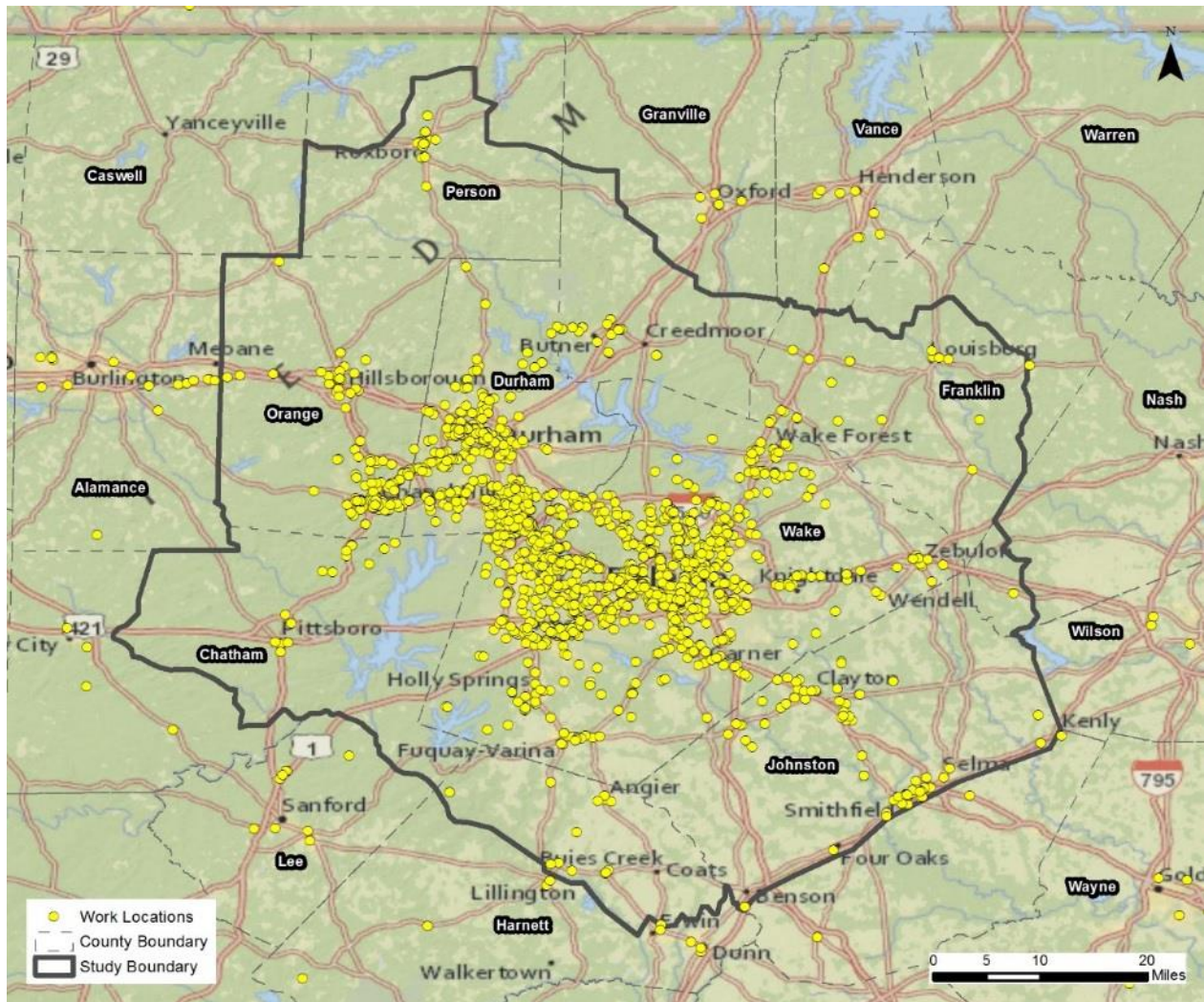
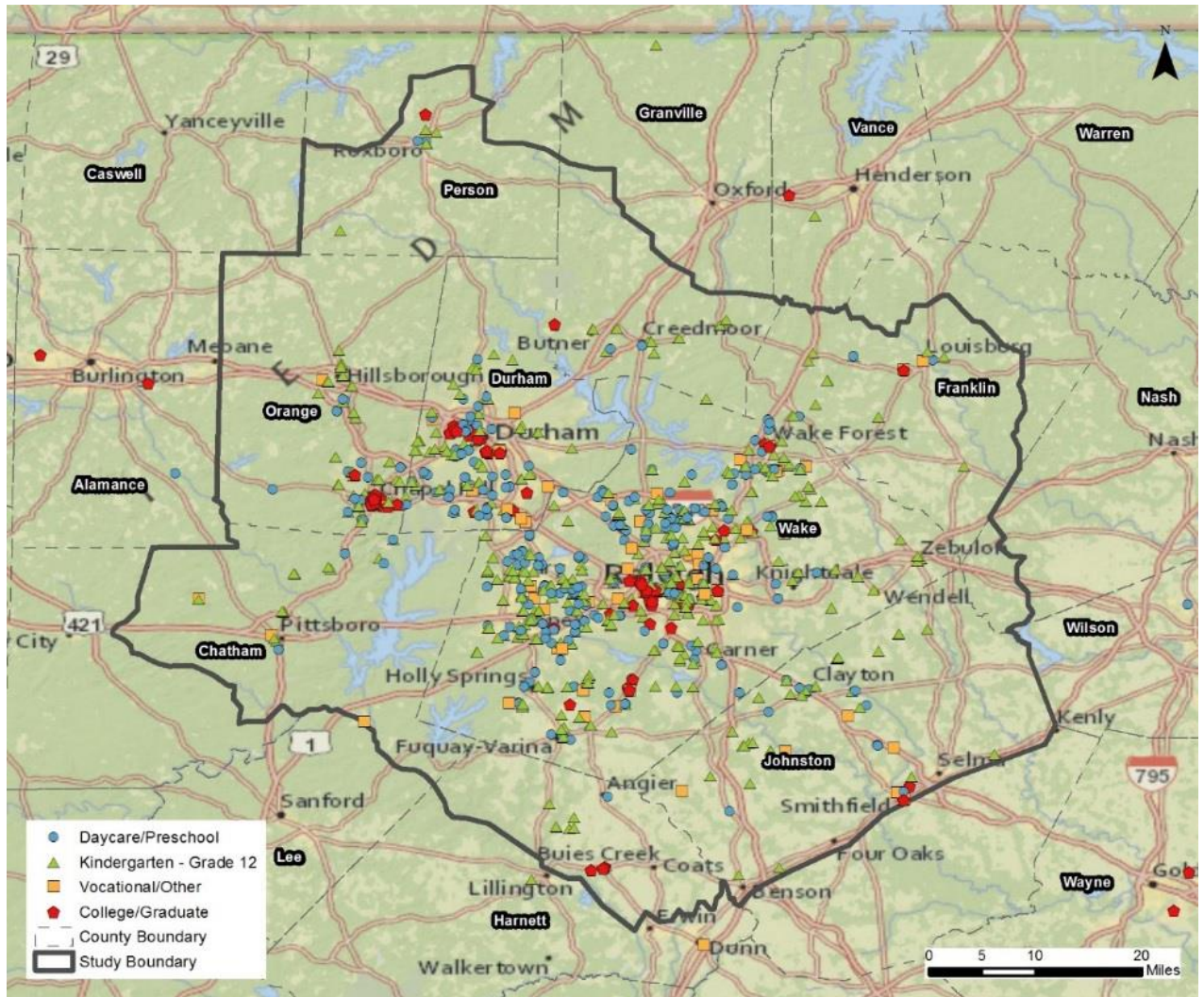


FIGURE 11: SCHOOL LOCATIONS FOR STUDENTS IN COMPLETE HOUSEHOLDS BY SCHOOL TYPE



7.5 | 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.

TABLE 40: RECRUITMENT INTERVIEW LENGTH BY HOUSEHOLD SIZE (WEB AND CALL CENTER)

	Web		Call Center		Combined	
	Recruit survey duration (minutes)		Recruit survey duration (minutes)		Recruit survey duration (minutes)	
Household size	Count	Median	Count	Median	Count	Median
1 person	987	10	202	9	1,189	10
2 people	1,668	15	143	12	1,811	15
3 people	555	16	20	17	575	16
4 or more people	597	18	12	27	609	18
Total	3,807	14	377	11	4,184	14

TABLE 41: RETRIEVAL INTERVIEW LENGTH BY HOUSEHOLD SIZE (WEB AND CALL CENTER)

	Web		Call Center		Combined	
	Retrieval survey duration (minutes)		Retrieval survey duration (minutes)		Retrieval survey duration (minutes)	
Household Size	Count	Median	Count	Median	Count	Median
1 person	962	15	227	13	1,189	15
2 people	1,620	26	191	18	1,811	25
3 people	551	27	24	23	575	27
4 or more people	591	33	18	34	609	33
Total	3,724	24	460	16	4,184	23

8.0 EXPANSION AND WEIGHTING

8.1 | THE ROLE OF WEIGHTING

Household travel surveys only sample a fraction of a region’s population, and in order for the resulting datasets to be used to analyze and make inferences about the population at large, it is sometimes necessary to perform a data weighting process. The unweighted demographic and geographic distributions for a survey dataset are the result of the sampling plan, adjustments made during survey administration, and the final response rates. Depending on the outcome of these factors, the resulting data are not necessarily fully representative of the study population in important demographic or geographic characteristics. There is often bias attributable to non-response, and by assigning lower weights to households and person types that were “overrepresented” in the survey, and assigning higher weights to combinations that were “underrepresented,” these non-response biases can be mitigated.

The weighting process compares selected demographics in the survey to external control data and then adjusts the survey dataset to improve its representativeness. The basic process to weight this dataset was to first expand the data to the population, establish target variables and marginal distributions for weighting, and then weight the survey data to match the target marginal distributions using an iterative proportional fitting algorithm. These steps are described below, but for a more detailed explanation of the data weighting process, please review the weighting memo provided in Appendix K.

8.2 | FIRST STAGE EXPANSION

The first step in the weighting process uses the “naïve” assumption that there are no non-response biases in the data, so by simply using an expansion factor, based upon the probability of sampling a household, the data will yield a representative sample. In this study, block groups in the study area were divided into two sampling segments. As described in the sampling plan, the “Oversample” block groups received invitations at a higher rate than the “Regular” block groups. The simplest approach to expansion would be to calculate two expansion weights, one for each sampling segment. However, because the weighting process occurred in four distinct regions (defined below), eight expansion factors were created, with the following logic:

$$\text{Expansion factor for region} = \frac{\text{Total HHs in region}}{\text{Survey HHs in region}} = \frac{1}{\text{Sample Rate for region}}$$

TABLE 42: FIRST STAGE EXPANSION FACTORS, BY SAMPLE SEGMENT AND WEIGHTING REGION

SAMPLE SEGMENT AND WEIGHTING REGION	TOTAL HHs (ACS 2010-2014)	STUDY COMPLETES (# HHS)	SAMPLE RATE	INITIAL EXPANSION FACTOR
Durham County Regular	86,670	514	0.593%	168.6187
Rest of DCHC Regular	62,307	476	0.764%	130.8971
Wake County Regular	326,003	2,214	0.679%	147.2462
Rest of CAMPO Regular	92,583	390	0.421%	237.3923
Regular Sample Total*	567,563	3,594	0.633%	157.9196



SAMPLE SEGMENT AND WEIGHTING REGION	TOTAL HHs (ACS 2010-2014)	STUDY COMPLETES (# HHS)	SAMPLE RATE	INITIAL EXPANSION FACTOR
Durham County Oversample	26,894	174	0.647%	154.5632
Rest of DCHC Oversample	20,051	170	0.848%	117.9471
Wake County Oversample	29,644	203	0.685%	146.0296
Rest of CAMPO Oversample	7,613	28	0.368%	271.8929
Oversample Total*	84,202	575	0.683%	146.4383
Total*	651,765	4,169	0.640%	156.3361
<i>*Note that the expansion factors listed for each of the totals were not actually used in the weighting and expansion process, but are listed here for reference and comparison.</i>				

8.3 | WEIGHTING TARGETS AND PROCESSES

The next step of weighting involves identifying the relevant demographic variables and geographies, against which the expanded data will be compared and adjusted. After identifying the variables, the initial expansion weights are then adjusted to match the demographic data targets from the ACS 2010–2014 five-year estimates. The target dimensions selected for weighting included:

- Household size (1, 2, 3, 4, 5+);
- Household number of vehicles owned (0, 1, 2, 3+);
- Household number of workers (0, 1, 2, 3+);
- Age of head of household⁵ (Under 35, 35-64, 65 or older);
- Household income group (\$0-25K, \$25-50K, \$50-75K, \$75-100K, \$100-150K, and \$150K+);
- Household contains children under age 18 (yes, no).

These variables were chosen to counteract the various non-response biases that are most relevant to modeling travel behavior. Furthermore, the categories used (e.g., household size 5+) attempt to balance the desire for detailed analysis while avoiding both small ACS targets and small “cells” of households from the survey data, each of which can result in extreme variation in the resulting weights.

Beyond choosing the demographic variables for weighting, the region within which the weighting process takes place must also be defined. Using the various geographies available for the study, including counties, PUMAs, the MPO regions, and the study region, itself, four separate “weighting subregions” were specified, each containing two or more “subareas.” Various aspects of the weighting process took place within each of these subregions or subareas, offering tighter control of the resulting weights. These geographies were designed to balance the desire for detailed weighting targets for each region with the desire to maintain stable

⁵ In the survey, the “head of household” was identified as the respondent who completed the recruit survey.

weighting factors and avoid any “empty cells” (i.e., data categories that contain zero completed HHs, which can contribute to weighting problems). The resulting subregions and subareas are:

1. Durham County: This subregion has two subareas, PUMAs 1301 and 1302.
2. Referred to as “Rest of DCHC”, even though it contains some areas beyond the DCHC boundaries: This subregion contains three subareas, Orange County, Chatham County, and Person County, with the latter two being partial counties.
3. Wake County: This subregion has eight subareas, PUMAs 1201-1208.
4. Referred to as “Rest of CAMPO”, even though it contains some areas beyond the MPO boundaries: This subregion has four subareas—Franklin County, Granville County, Hartnett County, and Johnston County plus a sliver of Nash County. Because the area of Nash County is so small (less than 1,500 households), it is grouped with adjacent Johnston County as a single subarea.

As the following tables demonstrate (Table 43 through Table 48), moving from an expanded dataset to a weighted dataset highlights the various ways in which certain populations or behaviors are over- or underrepresented. If there were no non-response biases in the surveyed population and methods, the differences between the two datasets on these measures would all be close to zero. As expected, however, the results show some of the typical biases observed in recent surveys using address-based-sampling (ABS). The tables show those groups that are underrepresented in shades of orange and those that are overrepresented in shades of blue. The groups that are most underrepresented are:

- Larger households, particularly those with 5+ people
- Households with 3+ workers
- Households with children under 18
- Low-income households, particularly those with income under \$25K
- Zero-vehicle households
- Households in Person County

The first three groups are related to the greater difficulty of getting complete responses from larger households, partly due to the increased respondent burden, and partly due to such households generally being busier and more time-constrained.

The next two variables (low-income and zero-vehicle HH) are groups that were addressed in the oversampling, but it is clear that even stronger oversampling would be needed to fully overcome the lower response rates from such households. (It may not even be possible to overcome this issue using geography-based oversampling, unless the households tend to be very concentrated in specific block groups.)

The household types that are most overrepresented are:

- Households with householder (or head of household) age 65 or older
- Households with income of \$75-150K

These types of biases are very common in household travel surveys, although the option for completing the survey online helps to counteract the age bias somewhat (otherwise it would be even more pronounced). The reweighting procedure described below is designed to correct for these non-response biases in the final weighted sample.



TABLE 43: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: HH SIZE

Subregion	Initial expansion: % Difference from HH size targets					Total
	1 person	2 people	3 people	4 people	5+ people	
Durham County	3.0%	29.4%	-20.4%	-29.9%	-66.4%	0.0%
Rest of DCHC	0.7%	27.7%	-22.3%	-37.6%	-38.1%	0.0%
Wake County	2.2%	29.3%	-15.9%	-24.8%	-40.3%	0.0%
Rest of CAMPO	16.3%	23.8%	-6.1%	-29.0%	-62.7%	0.0%
Total	3.9%	28.2%	-15.7%	-27.7%	-48.1%	0.0%

TABLE 44: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: HH WORKERS

Subregion	Initial expansion: % Difference from HH worker targets				Total
	0 workers	1 worker	2 workers	3+workers	
Durham County	10.6%	-12.4%	18.7%	-54.3%	0.0%
Rest of DCHC	20.3%	-11.7%		-43.4%	0.0%
Wake County	32.8%	-7.8%	0.5%	-48.4%	0.0%
Rest of CAMPO	29.3%	-19.5%	7.3%	-45.5%	0.0%
Total	25.9%	-10.7%	4.7%	-48.4%	0.0%

TABLE 45: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: HH VEHICLES

Subregion	Initial expansion: % Difference from HH vehicle targets				Total
	0 vehicles	1 vehicle	2 vehicles	3+vehicles	
Durham County	-61.0%	0.5%	26.3%	-30.1%	0.0%
Rest of DCHC	-44.4%	7.6%	10.3%	-14.9%	0.0%
Wake County	-51.0%	1.5%	10.5%	-14.0%	0.0%
Rest of CAMPO	-44.1%	-4.8%	12.8%	-5.6%	0.0%
Total	-52.0%	1.2%	13.3%	-14.5%	0.0%

TABLE 46: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: HH INCOME

Subregion	Initial expansion: % Difference from HH income group targets						Total
	0-25K	25-50K	50-75K	75-100K	100-150K	150K plus	
Durham County	-52.4%	-24.7%	14.4%	34.7%	59.6%	42.9%	0.0%
Rest of DCHC	-45.4%	-16.9%	5.5%	53.0%	59.9%	-1.1%	0.0%
Wake County	-47.4%	-21.7%	7.3%	27.0%	33.8%	10.7%	0.0%
Rest of CAMPO	-34.2%	-17.5%	14.0%	22.3%	30.6%	63.0%	0.0%
Total	-45.7%	-20.9%	9.4%	30.2%	40.1%	16.5%	0.0%

TABLE 47: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: AGE OF HEAD OF HOUSEHOLD

Subregion	Initial expansion: % Diff. from HH head age targets			Total
	under 35	35-64	65 or over	
Durham County	-10.1%	-7.1%	42.1%	0.0%
Rest of DCHC	-27.5%	-8.1%	45.2%	0.0%
Wake County	-18.6%	-6.0%	53.1%	0.0%
Rest of CAMPO	-16.2%	-7.6%	38.5%	0.0%
Total	-17.4%	-6.7%	47.4%	0.0%

TABLE 48: INITIAL EXPANDED SAMPLE VERSUS ACS-BASED TARGETS: PRESENCE OF CHILDREN

Subregion	Initial expansion: % Difference from HH children targets		Total
	Has children	No children	
Durham County	-24.8%	9.4%	0.0%
Rest of DCHC	-24.1%	8.6%	0.0%
Wake County	-20.2%	10.9%	0.0%
Rest of CAMPO	-22.1%	11.6%	0.0%
Total	-21.6%	10.4%	0.0%

The data reweighting process was done using a standard iterative proportional fitting (IPF) procedure:

- Begin with the initial expansion weight for each household
- Loop on iterations
 - Loop on each target variable (the six household type variables and the subarea geographic variable)
 - Loop on the survey households and calculate the current weighted sum for each subregion and each category for the particular target variable
 - Loop on the survey households again and adjust the weight for each household by the ratio of the target value divided by the current weighted sum for the relevant subregion/variable category combination
 - Move to next target variable
- Continue iterations until the weighted sum matches the target value for each subregion/variable category combination.

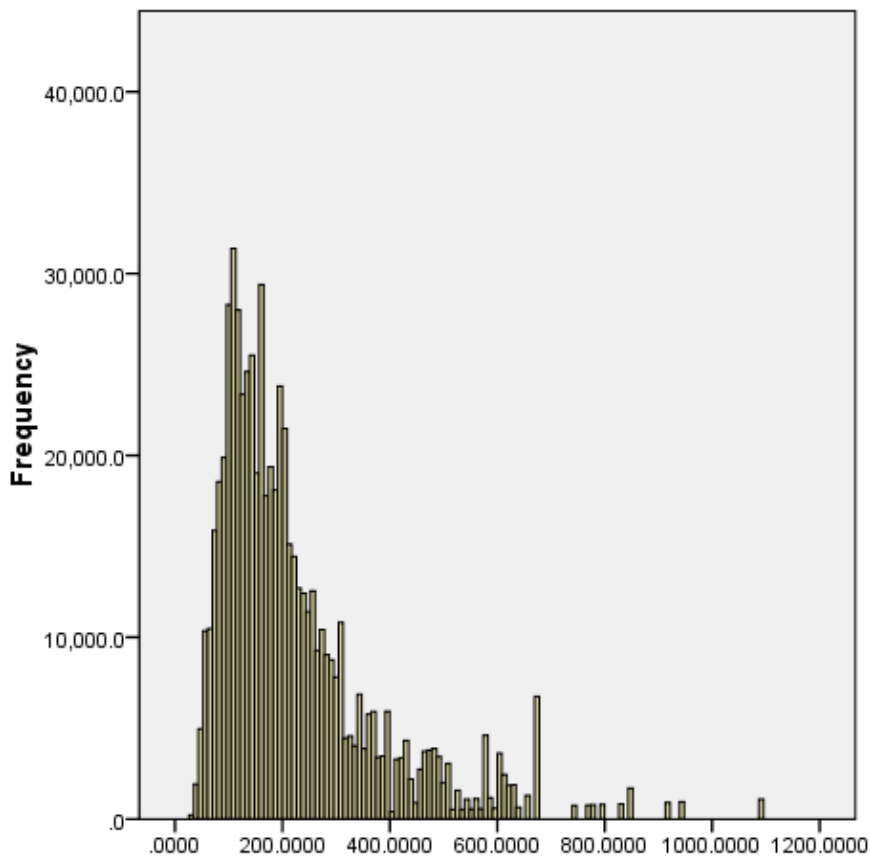
The weighting process was done using two statistical programs (Delphi and R), and each method produced identical results, lending confidence to the analysis.

8.4 | HOUSEHOLD, PERSON, AND VEHICLE WEIGHTS

The resulting household weights ranged from 29 to 1,087. However, the large majority of weights were between 100 and 300, and, overall, there are no extreme weights that could make the weighted results too sensitive to the exact weighting method, and there are no weights that are so close to zero that they would essentially eliminate some households from weighted analysis. Figure 12 provides a histogram showing the distribution of the final household weights (a histogram is used, rather than a frequency table, as there were 2,331 unique weights applied to the 4,169 complete households).



FIGURE 12 DISTRIBUTION OF HOUSEHOLD FINAL WEIGHTS



Additionally, the final weights for each sample segment and weighting region are shown in Table 49, where it may be seen that the oversample households generally received larger final weights than those they had after the initial “naïve” expansion. This demonstrates that while oversampling achieved the objective of increasing response rates for those regions, the populations of interest within those regions were still less likely to participate in the study.

TABLE 49: MEAN VALUES OF FINAL WEIGHTS, BY SAMPLE SEGMENT AND WEIGHTING REGION

SAMPLE SEGMENT AND WEIGHTING REGION	TOTAL HHS (ACS 2010-2014)	STUDY COMPLETES (# HHS)	INITIAL EXPANSION FACTOR	FINAL WEIGHT
Durham County Regular	86,670	514	168.6187	159.6113
Rest of DCHC Regular	62,307	476	130.8971	125.38
Wake County Regular	326,003	2,214	147.2462	145.1939
Rest of CAMPO Regular	92,583	390	237.3923	231.816
Regular Sample Total*	567,563	3,594	157.9196	154.0313
Durham County Oversample	26,894	174	154.5632	181.1711
Rest of DCHC Oversample	20,051	170	117.9471	133.3949
Wake County Oversample	29,644	203	146.0296	168.4121
Rest of CAMPO Oversample	7,613	28	271.8929	349.5633
Oversample Total*	84,202	575	146.4383	170.7414
Total*	651,765	4,169	156.3361	156.3361

**Note the expansion factors listed for each of the totals, as well as the final weights shown here, were typically not applied at the household-level, but are aggregate figures listed for reference and comparison.*

The final household weights were also applied to the person- and vehicle-level data. The decision to apply these weights to the other datasets was made after evaluating each dataset and using GPS trip rate correction factors (described in the next section). Because the household weighting process included household size and number of household vehicles owned as target criteria, applying these household weights to the person and vehicle data results in relatively accurate comparisons against ACS totals and distributions. Any deviations from those ACS distributions are due to the top-level categories used in the weighting process being undervalued when these weights are applied (i.e., household size 5+ or HH vehicles owned 3+).

8.5 | TRIP WEIGHTS AND TRIP CORRECTION FACTORS

A subsample of respondents from the main study were re-contacted and asked to participate in a three-day smartphone-based survey using the rMove app. By comparing the trips in the smartphone-based data to those in the diary-based data, it is possible to estimate the extent to which trips were under-reported with the diary-based method. Such comparisons can be done at the trip-level, comparing the distributions of trips by mode, purpose, distance, and time of day, and also at the person-day level, comparing the number of trips per day reported by respondents with different characteristics. Once again, for further detail on the trip weighting and trip correction process, please review the weighting memo in Appendix K.

The key steps used for the comparison included the following:

- Merge the trips from the diary-based data with all trips from the smartphone-based data for which the key questions on travel mode and activity purpose were answered. For this study, this means that



most respondents have just one-day of trip data (the travel diary day), while others have four days of trip data (the diary day plus three days of using the rMove app).

- Screen out any trips made by respondents under age 18, as they were not eligible to participate in the smartphone survey, so no data analysis or trip weight adjustment was done for children under 18.
- For the smartphone-based data, screen out any person-days for which one or more trips is missing response data on trip mode or purpose. (This was a small percentage of GPS person-days.)

Additionally, three separate respondent types were distinguished when performing trip comparisons:

- **“smartphone”** data are from the rMove app.
- **“diary-own smartphone”** data are from the diary-based survey for people age 18+ who owned a sufficiently recent model of Android or iPhone (and were eligible to participate in the rMove follow-on survey).
- **“diary-no smartphone”** data are from the diary-based survey for people age 18+ who did not own a sufficiently recent model of Android or iPhone (and were not eligible to participate in the rMove follow-on survey).

The latter two groups were analyzed separately because the first group of smartphone-owners is representative of the characteristics of those who participated in the rMove survey, while non-smartphone-owning adults are more likely to be in the older age groups and/or the lower income groups, and are therefore likely to have different travel characteristics. It is the first two data/respondent types—“smartphone” and “diary-own smartphone”—that we would expect to show the same results if there were no non-response bias in the diary-based data.

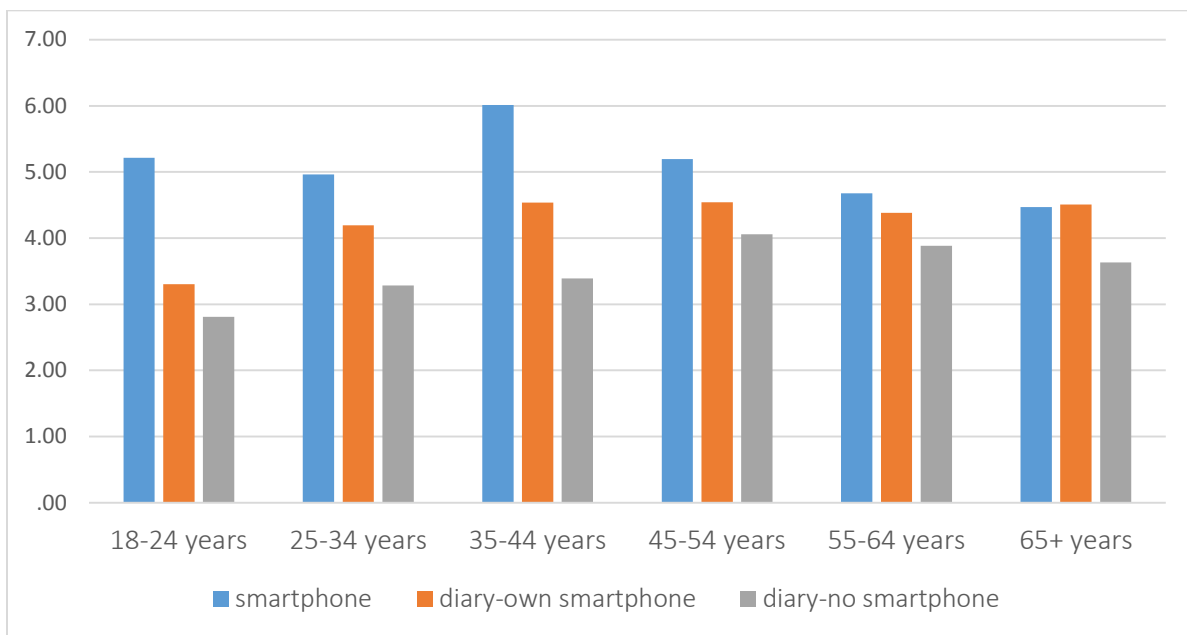
Having already done such comparisons on data from two previous rMove surveys among respondents from earlier diary-based surveys (in the regions around Seattle, WA and Madison, IN), RSG had an idea of what to expect. The Triangle data provided findings consistent to those two earlier studies:

- When comparing all trips for persons age 18+ who own smartphones (i.e., those eligible to participate in the rMove survey), the smartphone data had 20-30% more trips per person-day than the diary-based data, with an average in the range of 5-6 trips per day for smartphone-based data, versus 4-5 trips per day for diary-based data.
- When looking at trip rates by person type, a key difference was that the youngest age groups, such as 18-24, reported fewer trips than the older age groups in diary-based surveys but not in the smartphone-based surveys, suggesting a non-reporting bias among young respondents in diary-based surveys.
- Another consistent finding was by income group, with those in the higher income groups showing a larger difference between the smartphone-based and diary-based data, suggesting that the smartphone method may be better at capturing trips for busier, higher income respondents.
- When looking at the characteristics of the trips themselves, there was not much difference between the data types in terms of mode share or time of day. The main differences were a higher percentage

of non-home-based trips and a higher percentage of short-distance auto trips in the smartphone-based data, suggesting that the smartphone method is better at capturing intermediate stops made on multi-stop tours, particularly those made by car.

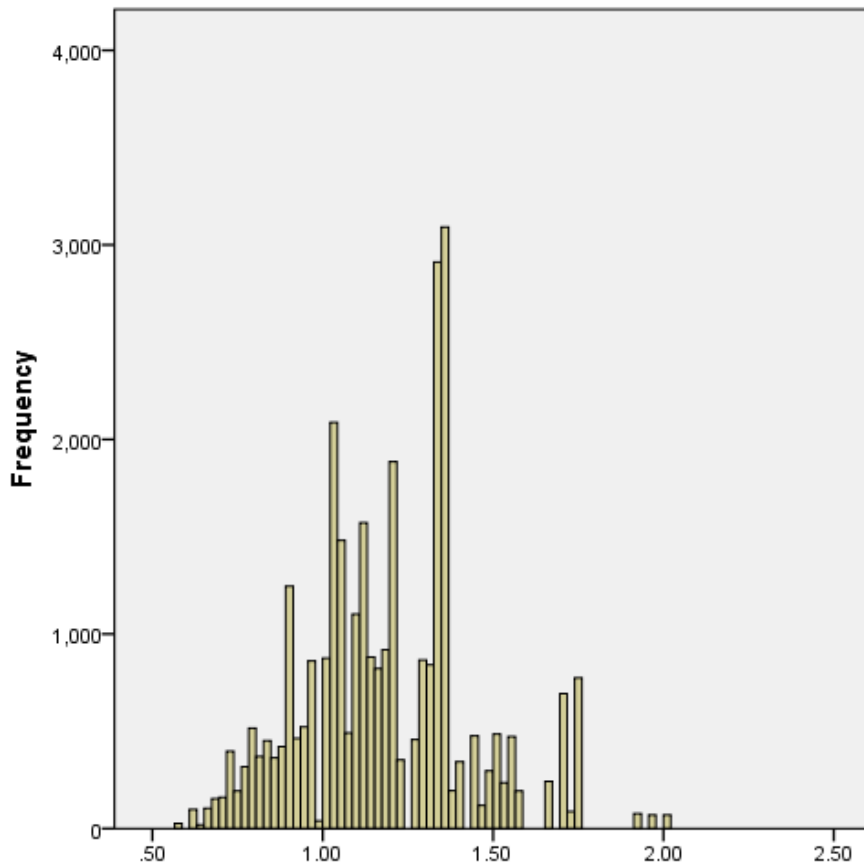
As an example of the analysis behind these findings, Figure 13 shows trips per day by age group and data type, highlighting important differences in trip reporting by age.

FIGURE 13 AVERAGE TRIPS PER DAY BY DATA TYPE AND AGE GROUP (WEIGHTED DATA)



The final trip weights and correction factors were based upon the participant’s age, household income, and origin-destination type (i.e., “work to home” trip), with each variable receiving its own adjustment factors that collectively combine to form the trip weights. There are 80 distinct trip weights, ranging from 0.585 to 2.016, with a mean of 1.148 (implying an overall increase in trip rates of 14.8%). The final weights are applied at the trip-level. However, they only impact the trips reported through the one-day online diary (rather than through rMove). Figure 14 shows a histogram of the resulting trip weights.

FIGURE 14 HISTOGRAM OF FINAL TRIP WEIGHTS



This trip weighting process was intentionally conservative, only adjusting for types of non-response biases that had also been seen in earlier analyses using smartphone-based data, and not interpreting the data or statistics too precisely. In addition to using a new data collection technology (smartphone apps), RSG used a new data comparison context—comparing data with a large number of observations and the same variables, but from partially overlapping samples on different travel days. This method provides the advantage of having all of the same information on the GPS trips and diary trips to do a full comparison, but the potential disadvantage that there are fewer comparable previous studies for guidance (which is why the consistency of these findings with the Seattle and Indiana analyses has been stressed as important).

9.0 WEIGHTED SURVEY RESULTS

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

1. Household-level data;
2. Person-level data;
3. Vehicle-level data; and
4. Trip-level data.

All of the data can be linked to individual households (the highest level), and trip data can be linked to individual people, providing context for reported travel behaviors. This section of the report summarizes the survey responses at all of these levels, presenting unweighted and weighted survey results side-by-side. The corresponding ACS data (5-year, 2010-2014) are also displayed in some of the tables.

9.1 | HOUSEHOLD-LEVEL DATA

The household-level survey measurements may be compared to demographic profiles of the population. ACS 2010–2014 five-year estimates are used for comparison in this report because the sampling plan drew upon population data from this source.⁶ The demographic distributions of the entire Triangle region were combined to provide comparisons for the total survey distribution (though it is acknowledged that demographic profiles vary across the region). Unweighted (raw) and expanded/weighted summary results are shown in Table 50.

TABLE 50: 2016 SURVEY RESULTS SUMMARY

	Unweighted	Weighted
Households	4,184	651,765
Mean HH Size	2.21	2.47
Persons⁷	9,232	1,679,663
Vehicles	7,684	1,196,862
Mean Vehicles per HH	1.84	1.84
Trips	38,267	7,357,137
Mean Trips per HH	9.15	11.29
Mean Trips per Person	4.15	4.57

⁶ Note: The sample plan used 5-year ACS data 2009-2013, the most recent data available when the sample plan was developed. The survey data were weighted to 5-year ACS data 2010-2014. The most recent available when weighting was conducted. The one exception to using this data is detailed in the footnote below regarding the person totals.

⁷ The person counts shown in Table 50 and in Section 9.2 were adjusted at NCSU-ITRE’s request. Using the weighting process as described in this report and using the ACS 5-year data from 2010-2014 results in 1,609,979 persons in the study region. ITRE provided separate population totals by county, derived from the 2013 TRM model, totaling 1,679,663 persons, which were used here instead.

Household-level data collection results by study area county are shown in Table 51.

TABLE 51: HOUSEHOLD SURVEY RESULTS BY COUNTY (UNWEIGHTED, WEIGHTED, AND ACS)

County	Unweighted Count	Unweighted %	Weighted Count	Weighted %	ACS Count	ACS %
Durham	688	16.5%	113,564	17.4%	113,564	17.9%
Orange	444	10.7%	51,419	7.9%	51,419	8.8%
Wake	2,417	58.0%	355,647	54.6%	355,647	53.1%
Chatham*	148	3.6%	17,817	2.7%	17,817	2.3%
Franklin*	85	2.0%	20,697	3.2%	20,697	2.9%
Granville*	43	1.0%	11,073	1.7%	11,073	1.9%
Harnett*	48	1.2%	12,998	2.0%	12,998	2.0%
Johnston*	237	5.7%	53,787	8.3%	53,970	8.2%
Nash*	5	.1%	1,641	.3%	1,458	.4%
Person*	54	1.3%	13,122	2.0%	13,122	2.7%
Total	4,169	100.0%	651,765	100.0%	651,765	100.0%

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

Household size, income, and vehicle ownership are three elements that typically play a significant role in household travel behavior, and the survey results and ACS estimates for these variables are shown in Table 52.

Table 53 and Table 54. The household characteristics of the survey sample are relatively close to the regional characteristics. The observable differences are typical of household travel studies—there are fewer low-income and large households in the survey sample, as compared to the population. Low-income households are frequently underrepresented in many surveys, and larger households can be difficult to recruit and retain, due to the additional burden per respondent for the household overall. However, due in part to the sample design and recruitment and retention strategies (described previously), the differences between the unweighted responses and the regional population are relatively minor.

The methodology for weighting the dataset was described in Section 8.0. Comparing the household size and income distributions of the weighted sample to ACS distributions shows that once the weights are applied, the distributions match the estimated population profile more closely. For example, in the unweighted sample, two-person households were overrepresented by approximately 10%, but the weighted sample matched the ACS estimate.

TABLE 52: HOUSEHOLD SIZE (UNWEIGHTED, WEIGHTED, AND ACS)

Household Size	Unweighted Count	Unweighted %	Weighted Count	Weighted %	ACS Count	ACS %
1 person	1,189	28.4%	176,852	27.1%	176,852	27.1%
2 people	1,811	43.3%	219,566	33.7%	219,566	33.7%
3 people	575	13.7%	108,238	16.6%	108,238	16.6%
4 or more people	609	14.6%	147,109	22.6%	147,109	22.6%

Total	4,184	100.0%	651,765	100.0%	651,765	100.0%
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TABLE 53: HOUSEHOLD INCOME (UNWEIGHTED, WEIGHTED, AND ACS)

Income	Unweighted Count	Unweighted %	Weighted Count	Weighted %	ACS Count	ACS %
Under \$25,000	421	10.1%	123,830	19.0%	123,830	19.0%
\$25,000-\$49,999	755	18.1%	151,019	23.2%	151,019	23.2%
\$50,000-\$74,999	804	19.3%	115,813	17.8%	115,813	17.8%
\$75,000-\$99,999	692	16.6%	83,272	12.8%	83,272	12.8%
\$100,000 or more	1,497	35.9%	177,831	27.3%	177,831	27.3%
Total	4,169	100.0%	651,765	100.0%	651,765	100.0%

TABLE 54: VEHICLE OWNERSHIP (UNWEIGHTED, WEIGHTED, AND ACS)

Household Vehicles	Unweighted Count	Unweighted %	Weighted Count	Weighted %	ACS Count	ACS %
0 (no vehicles)	113	2.7%	36,200	5.6%	36,200	5.6%
1 vehicle	1,400	33.5%	212,789	32.6%	212,789	32.6%
2 vehicles	1,948	46.6%	267,972	41.1%	267,972	41.1%
3 or more vehicles	723	17.3%	134,804	20.7%	134,804	20.7%
Total	4,184	100.0%	651,765	100.0%	651,765	100.0%

9.2 | PERSON-LEVEL DATA

PERSON-LEVEL RESULTS FROM THE SURVEY CAN ALSO BE COMPARED TO ACS DEMOGRAPHIC SECTION. TABLE 55 AND



Table 56 show the unweighted person response distributions for person age and gender as compared to the weighted distributions. As noted earlier, the weighted population counts here (1,679,663) reflect the weighting process as described in this report along with an adjustment based upon the person’s county of residence, so as to match the population totals provided by ITRE from the 2013 TRM model.

TABLE 55: AGE DISTRIBUTION (UNWEIGHTED, WEIGHTED, AND ACS)

Age	Unweighted Count	Unweighted %	Weighted Count	Weighted %	ACS Count	ACS %
Under 16 years	1,668	18.1%	385,842	23.0%	355,699	20.5%
16-24 years	535	5.8%	138,607	8.3%	245,580	14.2%
25-34 years	1,241	13.4%	238,741	14.2%	252,701	14.6%
35-44 years	1,300	14.1%	254,525	15.2%	261,317	15.1%
45-54 years	1,315	14.2%	238,010	14.2%	246,805	14.2%
55-64 years	1,458	15.8%	231,166	13.8%	191,638	11.1%
65 years or older	1,715	18.6%	192,771	11.5%	180,424	10.4%
Total	9,232	100.0%	1,679,663	100.0%	1,734,164	100.0%

TABLE 56: GENDER DISTRIBUTION (UNWEIGHTED, WEIGHTED, AND ACS)

Gender	Unweighted Count	Unweighted %	Weighted Count	Weighted %	ACS Count	ACS %
Male	4,336	47.0%	791,985	47.2%	843,099	48.6%
Female	4,896	53.0%	887,678	52.8%	891,065	51.4%
Total	9,232	100.0%	1,679,663	100.0%	1,734,164	100.0%

TABLE 57 AND

Table 58 show unweighted person response distributions for race and employment status, as compared to the weighted distributions.

TABLE 57: RACE DISTRIBUTION (UNWEIGHTED, WEIGHTED, AND ACS)

Race	Unweighted Count	Unweighted %	Weighted Count	Weighted %	ACS Count*	ACS %*
Asian	323	4.3%	53,814	4.2%	80,477	4.6%
Black or African American	651	8.6%	164,051	12.7%	385,009	22.2%
White	5,902	78.0%	945,783	73.1%	1,165,201	67.2%
Other (e.g., American Indian, Native Hawaiian, etc.)	88	1.2%	20,094	1.6%	61,037	3.5%
Two or more races	115	1.5%	26,004	2.0%	42,440	2.4%
Valid total	7,079	93.6%	1,209,746	100.0%	1,734,164	100.0%
Prefer not to answer	485	6.4%	84,075	0.0%	n/a	n/a
Total	7,564	100.0%	1,293,821	100.0%		

Note: The ACS totals here are for the entire population, while the race figures for the study are for adults only.

TABLE 58: EMPLOYMENT STATUS (UNWEIGHTED AND WEIGHTED)

Employment Status	Unweighted Count	Unweighted %	Weighted Count	Weighted %
Employed full-time (paid)	3,623	47.9%	609,563	47.1%
Employed part-time (paid)	649	8.6%	143,355	11.1%
Self-employed	437	5.8%	76,192	5.9%
Unpaid volunteer/unpaid intern	41	.5%	7,276	.6%
Homemaker	435	5.8%	91,801	7.1%
Valid total	5,185	68.5%	928,187	71.7%
Retired	1,737	23.0%	206,346	15.9%
Not currently employed	642	8.5%	159,288	12.3%
Total	7,564	100.0%	1,293,821	100.0%



9.3 | TRIP-LEVEL DATA

The overall trip rate was calculated by dividing the total number of trips by the total number of participating households and persons. Approximately 3.3% of households and 10.7% of people reported making no trips on their travel day. However, these households and individuals were included in average-trip rate calculations. Table 59 shows unweighted and weighted trip rates.

TABLE 59: HOUSEHOLD AND PERSON TRIP RATES

	Weighted Trips	Weighted Trip Rate
Weighted HH Trip Rate	7,357,137	11.29
Weighted Person Trip Rate	7,357,137	4.57

Table 60 shows household trip rates by county.

TABLE 60: HOUSEHOLD-LEVEL TRIP COUNTS AND TRIP RATES BY COUNTY

County	Unweighted Trips	Unweighted Trip Rate	Weighted Trips	Weighted Trip Rate
Durham	6,065	8.82	1,278,025	11.25
Orange	3,905	8.80	537,021	10.44
Wake	22,959	9.50	4,147,578	11.66
Chatham*	1,261	8.52	185,813	10.43
Franklin*	683	8.04	219,820	10.62
Granville*	423	9.84	125,790	11.36
Harnett*	414	8.63	148,524	11.43
Johnston*	2,037	8.59	599,185	11.14
Nash*	43	8.60	10,234	6.24
Person*	380	7.04	105,146	8.01
Total	38,170	9.16	7,357,137	11.29

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

As expected, larger households made more trips per household (Table 61).

TABLE 61: HOUSEHOLD TRIP COUNTS AND TRIP RATES BY HOUSEHOLD SIZE

Household Size	Unweighted Trips	Unweighted Trip Rate	Weighted Trips	Weighted Trip Rate
1 person	5,954	5.01	989,671	5.60
2 people	15,337	8.47	2,046,230	9.32
3 people	6,428	11.18	1,408,367	13.01
4 or more people	10,548	17.32	2,912,869	19.80
Total	38,267	9.15	7,357,137	11.29

TABLE 62: PERSON-LEVEL TRIP COUNTS AND TRIP RATES BY COUNTY

County	Unweighted Trips	Unweighted Trip Rate	Weighted Trips	Weighted Trip Rate
Durham	6,065	4.33	1,278,025	4.83
Orange	3,905	4.22	537,021	4.58
Wake	22,959	4.18	4,147,578	4.66
Chatham*	1,261	3.86	185,813	4.08
Franklin*	683	3.90	219,820	4.69
Granville*	423	3.95	125,790	3.98
Harnett*	414	4.27	148,524	4.92
Johnston*	2,037	3.68	599,185	4.02
Nash*	43	3.58	10,234	2.53
Person*	380	3.30	105,146	3.47
Total	38,170	4.15	7,357,137	4.57

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

TABLE 63: TRIP RATES BY GENDER (WEIGHTED AND UNWEIGHTED)

Gender	Unweighted Trips	Unweighted Trip Rate	Weighted Trips	Weighted Trip Rate
Male	17,396	4.01	3,236,883	4.27
Female	20,871	4.26	4,120,254	4.84
Total	38,267	4.15	7,357,137	4.57

TABLE 64: TRIP RATES BY AGE (WEIGHTED AND UNWEIGHTED)

Age	Unweighted Trips	Unweighted Trip Rate	Weighted Trips	Weighted Trip Rate
Under 16 years	5,526	3.31	1,199,165	3.23
16-24 years	1,771	3.31	582,464	4.40
25-34 years	5,202	4.19	1,194,173	5.22
35-44 years	5,981	4.60	1,407,447	5.77
45-54 years	6,043	4.60	1,173,889	5.14
55-64 years	6,325	4.34	1,005,752	4.54
65 years or older	7,419	4.33	794,248	4.31
Total	38,267	4.15	7,357,137	4.57

TABLE 65: TRIP COUNTS AND TRIP RATES BY RACE (WEIGHTED AND UNWEIGHTED)

Race	Unweighted Trips	Unweighted Trip Rate	Weighted Trips*	Weighted Trip Rate*
Asian	1,078	3.34	206,409	4.04
Black or African American	2,688	4.13	731,214	4.61
White	26,215	4.44	4,659,748	5.15
Other (e.g., American Indian, Native Hawaiian, etc.)	319	3.63	79,897	4.22
Two or more races	464	4.03	114,883	4.58
Total	30,764	4.35	5,792,152	5.00

Note: The totals here are for adults only, rather than the entire population.

TABLE 66: TRIP COUNTS AND TRIP RATES BY DRIVER LICENSURE (WEIGHTED AND UNWEIGHTED)

Has Driver's License	Unweighted Trips	Unweighted Trip Rate	Weighted Trips	Weighted Trip Rate
Yes, Driver's license	31,599	4.42	5,817,029	5.14
Yes, Learner's permit	293	3.02	70,912	3.61
No	6,375	3.20	1,469,196	3.20
Total	38,267	4.15	7,357,137	4.57

TABLE 67: TRIP COUNTS AND TRIP RATES BY WORKER STATUS (WEIGHTED AND UNWEIGHTED)

Worker Status	Unweighted Trips	Unweighted Trip Rate	Weighted Trips	Weighted Trip Rate
No, not worker	17,252	3.81	3,264,835	4.00
Yes, worker	21,015	4.46	4,092,302	5.16
Total	38,267	4.15	7,357,137	4.57

TABLE 68: TRIP COUNTS AND TRIP RATES BY UNIVERSITY STUDENT STATUS (WEIGHTED AND UNWEIGHTED)

University Student Status	Unweighted Trips	Unweighted Trip Rate	Weighted Trips	Weighted Trip Rate
No, not university student	36,584	4.15	6,854,189	4.53
Yes, university student	1,683	4.08	502,948	5.18
Total	38,267	4.15	7,357,137	4.57

Table 69 shows numbers of trips by destination activity, sorted by frequency of activity selection. The most common destination activity was “At home,” followed by trips to go shopping and to go to work.

TABLE 69: NUMBER OF TRIPS BY DESTINATION ACTIVITY (WEIGHTED AND UNWEIGHTED)

Trip Destination Activity	Unweighted Count	Unweighted %	Weighted Count	Weighted %
At home activity, not working (for pay) or schooling	12,560	32.8%	2,257,502	30.7%
Routine shopping (grocery, get gas, clothing, convenience store, household maintenance, etc.)	4,911	12.8%	1,010,096	13.7%
Working (for pay) at work or home	4,763	12.4%	785,386	10.7%
Recreation/entertainment (walk the dog, exercise/workout, go to a movie)	2,897	7.6%	527,324	7.2%
Dining out/take-out/coffee (eat at restaurant, get take-out/fast-food)	2,414	6.3%	486,186	6.6%
Attend school/class	2,037	5.3%	464,592	6.3%
Drop someone off	1,146	3.0%	272,739	3.7%
Pick someone up	1,097	2.9%	261,277	3.6%
Household errands (bank/ATM, post office, dry cleaning, car services, etc.)	992	2.6%	192,691	2.6%
Other work-related activity (meeting, visit, sales call, etc.)	710	1.9%	126,929	1.7%
Social (visit friends/relatives)	680	1.8%	150,807	2.0%
Medical visit (doctor, dentist, etc.)	668	1.7%	125,239	1.7%
Other (not at home)	664	1.7%	127,345	1.7%
Other school-related activity	657	1.7%	161,024	2.2%
Change type of transportation/Transfer to (take bus, airplane, park car or pickup parked car if walk 2+ blocks, etc.)	621	1.6%	140,317	1.9%
Religious, civic, or volunteer	520	1.4%	92,101	1.3%
Personal business (visit government office, attorney, accountant, etc.)	377	1.0%	67,041	.9%
Work-related: delivering goods or services	286	.7%	53,455	.7%
Shopping for major purchase/specialty item (appliance, electronics, new vehicle, major household repairs, etc.)	267	.7%	55,086	.7%
Total	38,267	100.0%	7,357,137	100.0%

Table 70 shows numbers of trips reported, by mode. Driving trips in a household vehicle comprised 78.4% of the total trips in the dataset. Walk/wheelchair and bicycle trips comprise just over 13.9% of trips, and bus trips accounted for 2.7% of all trips.



TABLE 70: NUMBERS OF TRIPS BY MODE (WEIGHTED AND UNWEIGHTED)

Mode	Unweighted Count	Unweighted %	Weighted Count	Weighted %
Vehicle in household (or motorcycle/moped)	30,012	78.4%	5,669,927	77.1%
Walk/jog/wheelchair	4,941	12.9%	932,271	12.7%
Other vehicle (e.g., rental, friend's car, carshare, taxi, work car)	1,546	4.0%	331,361	4.5%
Any bus (e.g., public bus, school/university bus, paratransit)	1,254	3.3%	312,049	4.2%
Bicycle	378	1.0%	83,611	1.1%
Other	136	.4%	27,917	.4%
Total	38,267	100.0%	7,357,137	100.0%

As shown in Table 71, shows the typical mode to work for employed adults and volunteers.

TABLE 71: TYPICAL MODE TO WORK, EMPLOYED ADULTS AND VOLUNTEERS (WEIGHTED AND UNWEIGHTED)

Mode	Unweighted Count	Unweighted %	Weighted Count	Weighted %
Drive alone	3,509	85.8%	579,162	83.4%
Carpool with only family/ household member(s)	261	6.4%	47,791	6.9%
Bus (public transit)	112	2.7%	22,193	3.2%
Bicycle	61	1.5%	11,061	1.6%
Walk/jog/wheelchair	56	1.4%	13,606	2.0%
Carpool with at least one person not in household	51	1.2%	11,380	1.6%
Other	18	.4%	4,039	.6%
Motorcycle/moped/scooter	9	.2%	1,749	.3%
Vanpool	8	.2%	1,892	.3%
Taxi or other hired car service (e.g., Lyft, Uber)	5	.1%	1,704	.2%
Private shuttle bus	1	.0%	163	.0%
Express school bus service	0	0.0%	0	0.0%
Paratransit	0	0.0%	0	0.0%
School bus	0	0.0%	0	0.0%
Train (any rail, subway, monorail)	0	0.0%	0	0.0%
Total	4,091	100.0%	694,741	100.0%

10.0 SUMMARY

The 2016 Triangle Region Household Travel Study (2016 HTS) 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 4,194 households completed the survey. These households provided data critical for updating and developing the Triangle Regional Model. Data from 4,184 households were included in the main (excluding smartphone GPS panel) data deliverable. Data from 407 households were included in the smartphone GPS data deliverable.



11.0 APPENDICIES

- A. QUESTIONNAIRE**
- B. SURVEY SCREENSHOTS**
- C. PRINT MATERIALS**
- D. EXAMPLE EMAIL REMINDERS**
- E. PUBLIC OUTREACH MATERIALS**
- F. OPEN-ENDED SURVEY COMMENTS**
- G. DATASET GUIDE**
- H. DATA CODEBOOK**
- I. UNWEIGHTED TABULATIONS**
- J. WEIGHTED TABULATIONS**
- K. WEIGHTING MEMO**
- L. SMARTPHONE GPS DATA COLLECTION**