Demographic, Physical Activity, and Route Characteristics Related to School Transportation: An Exploratory Study

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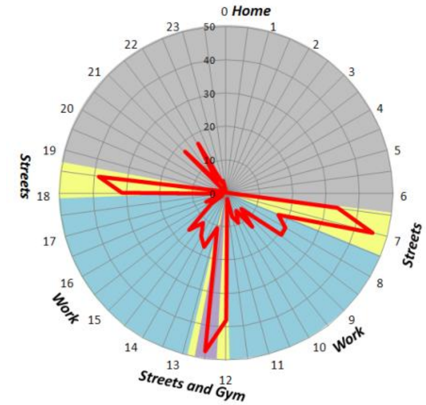
Background

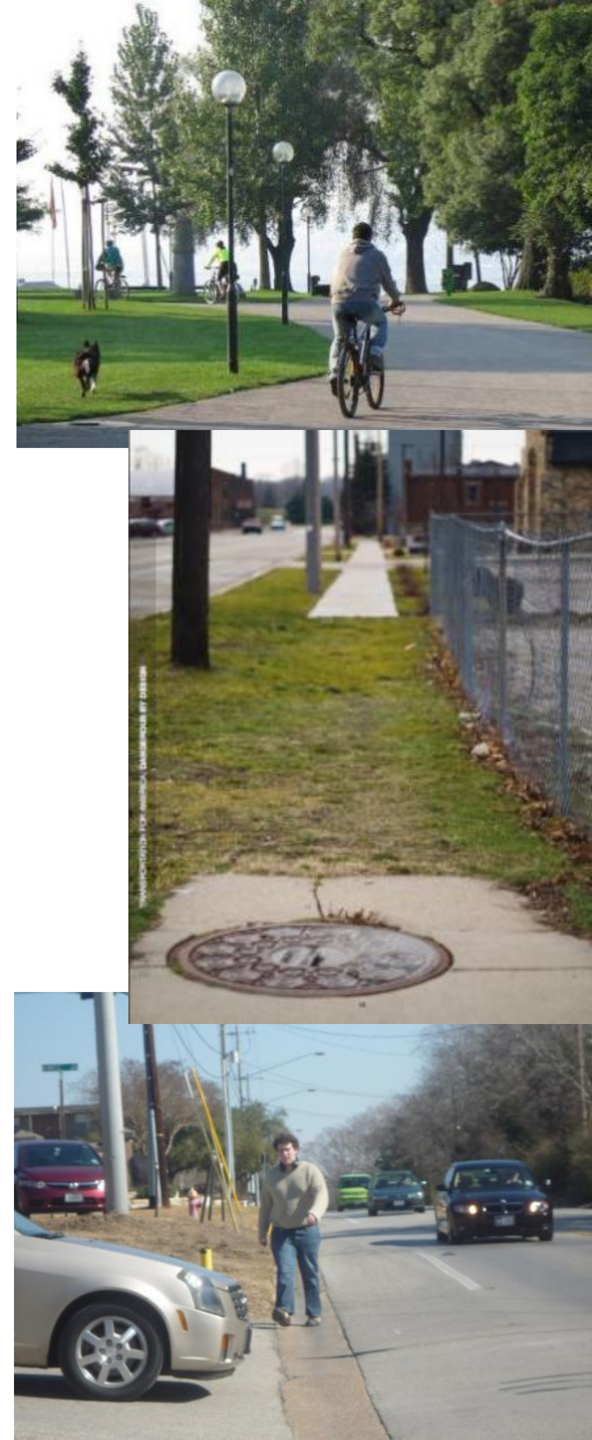


- **Active travel to school** has been widely promoted as a means to reverse the children obesity epidemic.
- Evidence indicates built environments around **homes** and **schools** and along the **routes** influence **parental decisions** for children's school travel mode choice.
- **Objective measurements** such as Global Positioning System (**GPS**) units and accelerometers emerge as promising tools to capture both the built environment and school commuting behaviors to overcome inherent limitations of conventional self-report measures, especially for children.
- **Challenges** exist in collecting such data especially among children, and due to the complexity in data processing/analysis.

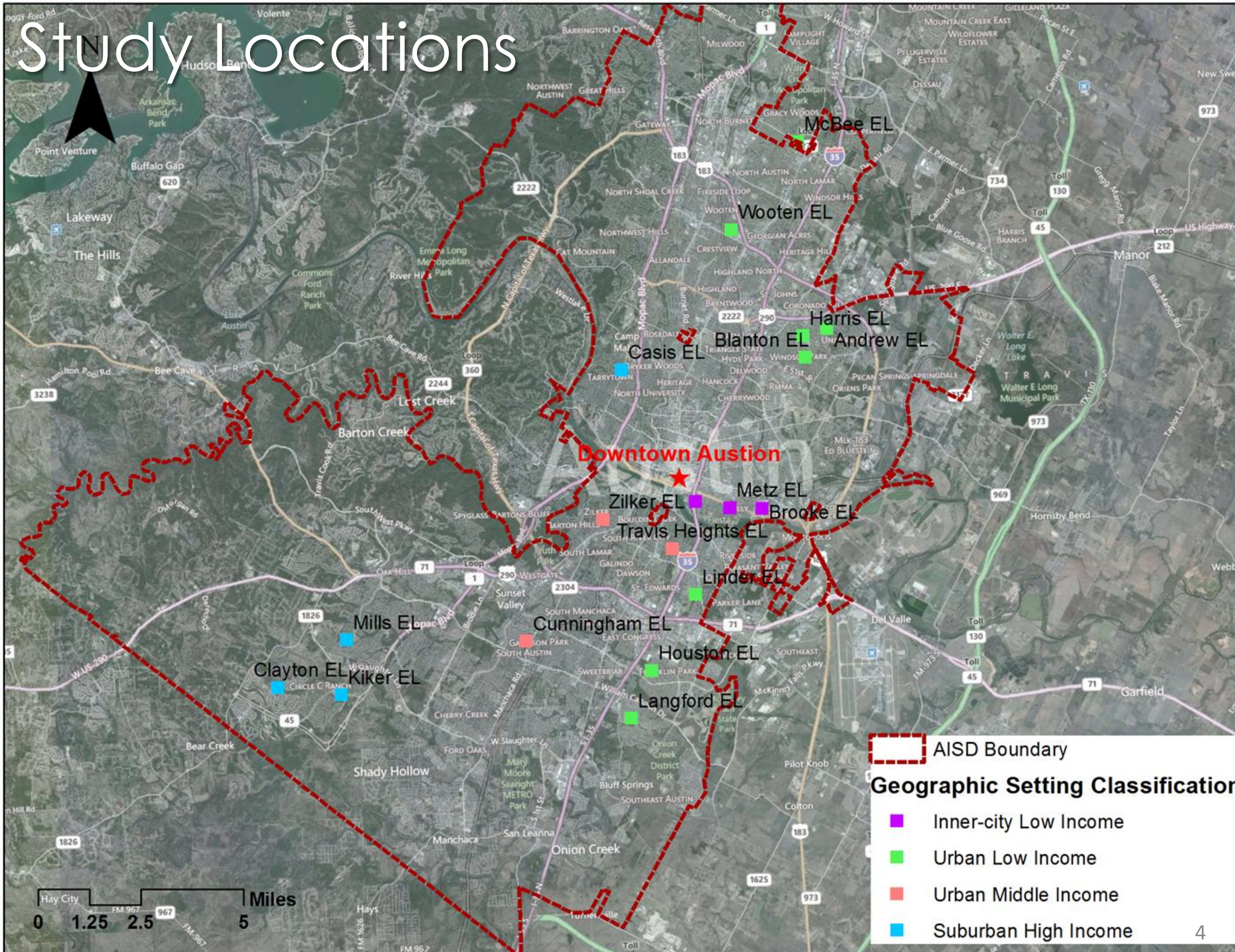
Objectives

1. Investigate the characteristics of children's home-to-school and school-to-home travels, in terms of demographic, physical activity, and route characteristics.

2. Assesse the contribution of active travel modes to the overall daily moderate-to-vigorous physical activity (MVPA), and variations in school trip characteristics by community settings.



Study Locations



Methods: Data Collection

Participants:

- 113 children from 18 elementary schools in Austin Independent School District in Texas

Survey period:

- Fall semester of 2009 ~ Spring semester of 2011

Measurement Devices:

- GPS unit (Garmin Forerunner 205) with smart recording data capture
- Accelerometer (ActiGraph GT3X) with15-sec data capture
- Travel Log (Self-report by children with parental help)
- Parental survey (personal, school travel, physical activity and environmental perception data)

Measurement Duration:

- 7 consecutive days
- 8 hours of daily accelerometer wearing time and 30% of active time considered valid

Methods: Instruments

Wieters M, Kim J and Lee C (2013). Assessment of available research instruments for measuring physical activity. *Journal of Physical Activity and Health*

	Garmin Foretrex		Garmin Forerunner		Global Sat DG-100		Wintec Easy Showily	
	Rating	% Correct	Rating	% Correct	Rating	% Correct	Rating	% Correct
Points Correctly plotted on sidewalk	**o**	67.1%	**+**	76.0%	**+**	74.9%	**-**	57.2 %
Points Correctly plotted on the correct side of the road	**o**	78.9%	**+**	98.8%	**+**	100%	**o**	85.4%
Points on course	**-**	71.6%	**+**	80.7%	**+**	80.49	**-**	71.8%
Points on course with tree coverage	**-**	73.0%	**+**	100%	**o**	82.80%	**+**	100%
Points on course while indoors**	**+**	100%	**+**	100%	**-**	46.1%	**+**	100%

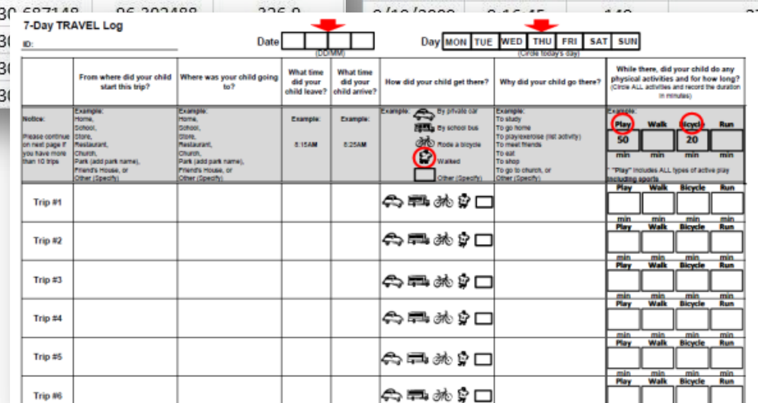
Methods: Instruments

1. **GPS:** Geographic Information
(Location, Speed, Time)

time	latitude	longitude	altitude (ft)
2009-09-19 09:14:23	30.687214	-96.302416	337.9
2009-09-19 09:14:31	30.687228	-96.302413	314.3
2009-09-19 09:14:42	30.687244	-96.302449	314.3
2009-09-19 09:14:52	30.687253	-96.302399	311.1
2009-09-19 09:15:06	30.68722	-96.302408	287.5
2009-09-19 09:15:12	30.687221	-96.302433	308
2009-09-19 09:15:19	30.687222	-96.30244	298.5
2009-09-19 09:15:54	30.687177	-96.302428	350.5
2009-09-19 09:16:05	30.687183	-96.302448	363.2
2009-09-19 09:16:36	30.687222	-96.302437	349
2009-09-19 09:16:48	30.687203	-96.302469	350.5
2009-09-19 09:16:52	30.687223	-96.302471	334.8
2009-09-19 09:16:56	30.687167	-96.302501	325.3
2009-09-19 09:16:59	[illegible]	[illegible]	[illegible]
2009-09-19 09:17:06	[illegible]	[illegible]	[illegible]
2009-09-19 09:17:47	[illegible]	[illegible]	[illegible]
2009-09-19 09:17:59	[illegible]	[illegible]	[illegible]

2. **Accelerometer:** Physical Activity Information
(PA intensity, Step Counts, Time)

Date	Time	Activity	Activity (Horizontal)	Steps
9/19/2009	9:14:30	9	18	1
9/19/2009	9:14:45	59	152	4
9/19/2009	9:15:00	95	202	8
9/19/2009	9:15:15	65	186	6
9/19/2009	9:15:30	45	123	5
9/19/2009	9:15:45	0	39	0
9/19/2009	9:16:00	1	56	0
9/19/2009	9:16:15	0	6	0
9/19/2009	9:16:30	45	99	2
[illegible]	[illegible]	[illegible]	[illegible]	4
[illegible]	[illegible]	[illegible]	[illegible]	5
[illegible]	[illegible]	[illegible]	[illegible]	0
[illegible]	[illegible]	[illegible]	[illegible]	0
[illegible]	[illegible]	[illegible]	[illegible]	0
[illegible]	[illegible]	[illegible]	[illegible]	4
[illegible]	[illegible]	[illegible]	[illegible]	1
[illegible]	[illegible]	[illegible]	[illegible]	4



3. **Travel Log:** Self Recorded Daily Travel Information
(Mode, Purpose, Time)

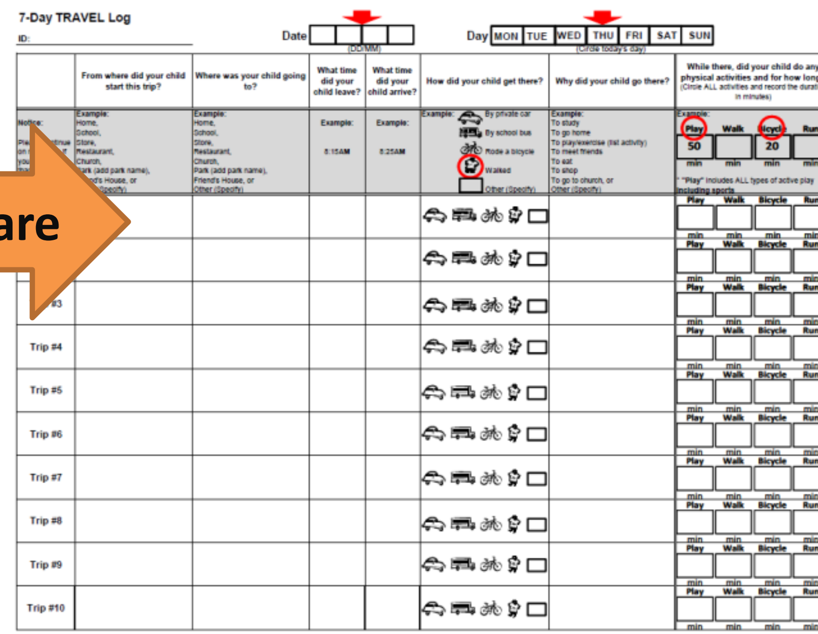
Methods: Data Processing

Synthesizing GPS and Accelerometer

Travel Mode Detection

Trip Identification

Compare



7-Day TRAVEL Log

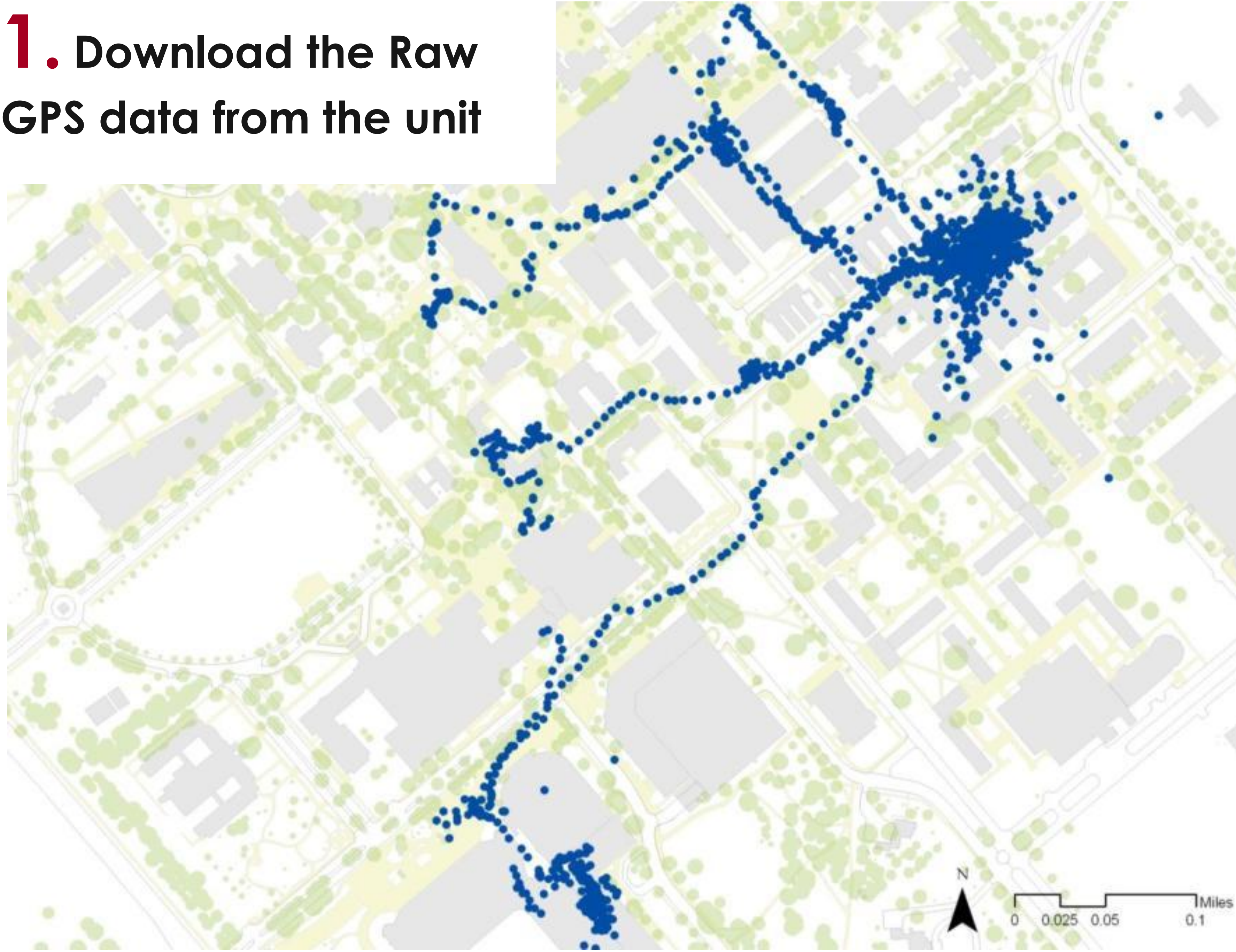
ID:

Date (DD/MM)

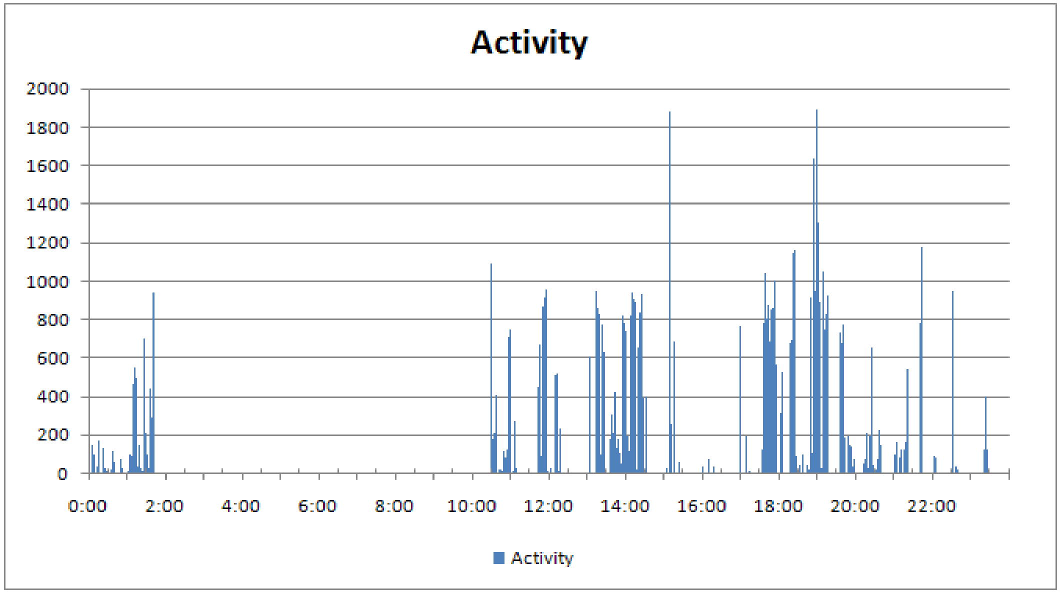
Day MON TUE WED THU FRI SAT SUN (Circle today's day)

	From where did your child start this trip?	Where was your child going to?	What time did your child leave?	What time did your child arrive?	How did your child get there?	Why did your child go there?	While there, did your child do any physical activities and for how long? (Circle ALL activities and record the duration in minutes)
Notice: Ple… on… you…	Example: Home, School, Store, Restaurant, Church, Park (add park name), …d's House, or …(Specify)	Example: Home, School, Store, Restaurant, Church, Park (add park name), Friend's House, or Other (Specify)	Example: 8:15AM	Example: 8:25AM	Example: By private car; By school bus; Rode a bicycle; Walked; Other (Specify)	Example: To study; To go home; To play/exercise (list activity); To meet friends; To eat; To shop; To go to church, or Other (Specify)	Example: Play 50 min; Walk min; Bicycle 20 min; Run min. * "Play" includes ALL types of active play including sports
							Play min; Walk min; Bicycle min; Run min
							Play min; Walk min; Bicycle min; Run min
…#3							Play min; Walk min; Bicycle min; Run min
Trip #4							Play min; Walk min; Bicycle min; Run min
Trip #5							Play min; Walk min; Bicycle min; Run min
Trip #6							Play min; Walk min; Bicycle min; Run min
Trip #7							Play min; Walk min; Bicycle min; Run min
Trip #8							Play min; Walk min; Bicycle min; Run min
Trip #9							Play min; Walk min; Bicycle min; Run min
Trip #10							Play min; Walk min; Bicycle min; Run min

1. Download the Raw GPS data from the unit



2. Download the Raw Accelerometer data

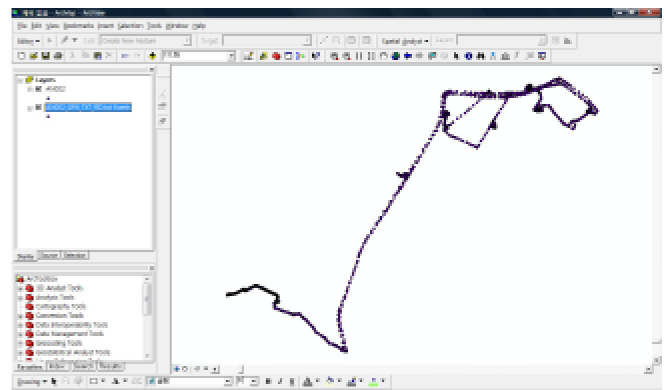


Date	Time	Activity	Activity (Horizontal)	3rd Axis	Steps
6/30/2009	8:13:00	0	0	4	0
6/30/2009	8:13:30	33	103	47	3
6/30/2009	8:14:00	225	228	149	7
6/30/2009	8:14:30	91	114	56	3
6/30/2009	8:15:00	378	165	198	13
6/30/2009	8:15:30	21	118	437	0
6/30/2009	8:16:00	887	1108	1535	33
6/30/2009	8:16:30	753	1008	1248	29
6/30/2009	8:17:00	942	1110	1414	37
6/30/2009	8:17:30	194	509	548	6
6/30/2009	8:18:00	209	239	540	2
6/30/2009	8:18:30	14	78	66	1
6/30/2009	8:19:00	227	260	541	2
6/30/2009	8:19:30	98	156	312	2
6/30/2009	8:20:00	36	126	127	1
6/30/2009	8:20:30	0	23	109	0
6/30/2009	8:21:00	0	18	24	0
6/30/2009	8:21:30	0	3	0	0
6/30/2009	8:22:00	0	21	2	0

3. Link GPS with Accelerometer data

- Use "**time**" as the common link
- Issues/challenges:
  - Missing or erroneous GPS data while indoors or under heavy canopy (buildings/trees)
  - Lack of clear (valid) thresholds/guidelines for data processing
  - Labor-intensive (need to develop special program to handle large samples)

REF: Rodriguez DA, Brown AL, and Troped PJ (2005). Portable global positioning units to complement accelerometry-based physical activity monitors. Medicine & Science in Sports & Exercise, S572-581.



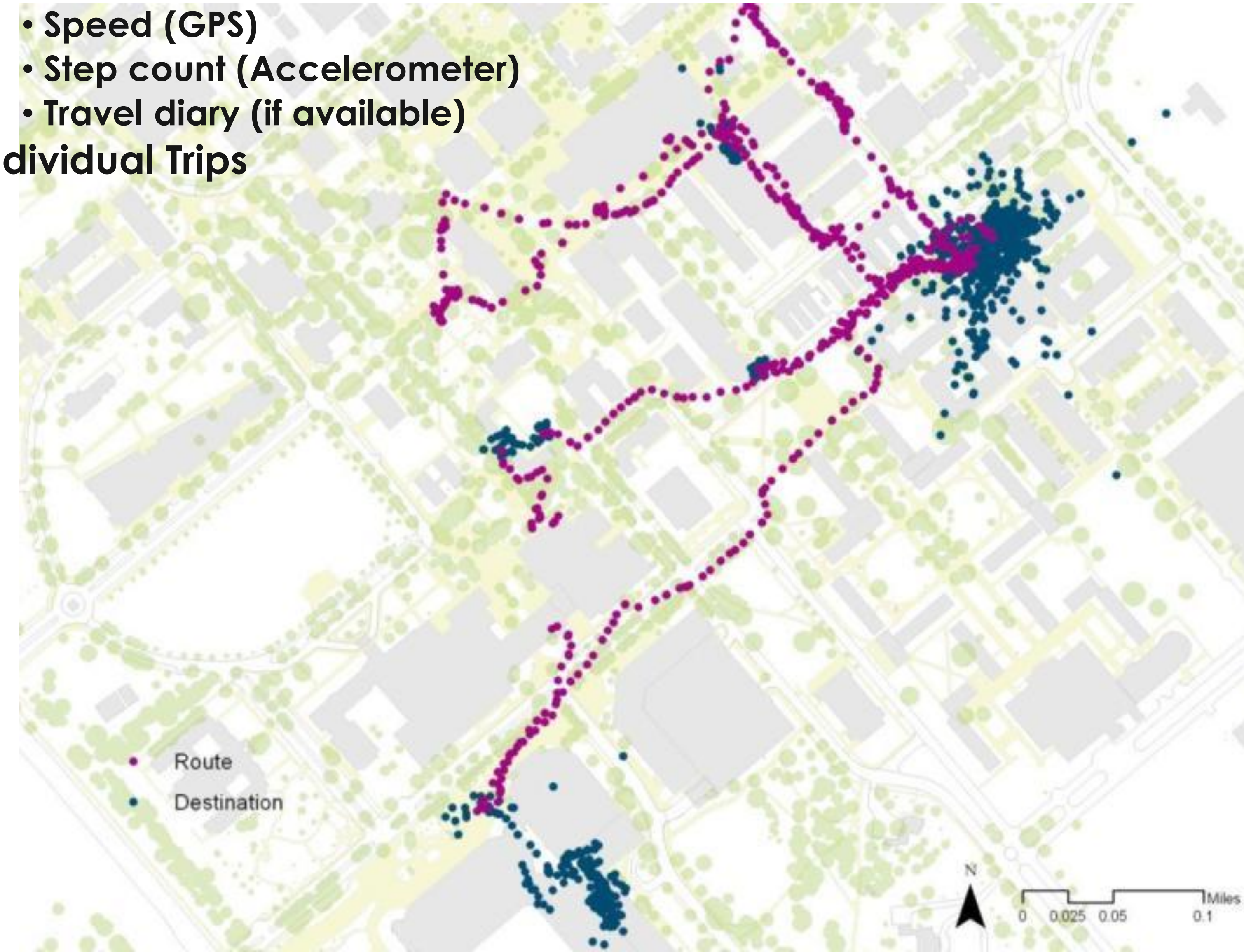
Software needed:
GPS Visualizer (to convert GPS raw data to GIS-compatible file)
A web-based program available from: http://www.gpsvisualizer.com/convert_input
Matlap (to merge GPS and Accelerometer data)
ArcGIS (to map the data and conduct spatial analysis)
Training Center and Way Point Manager (to download GPS data)
ActiGraph (to download Accelerometer data)

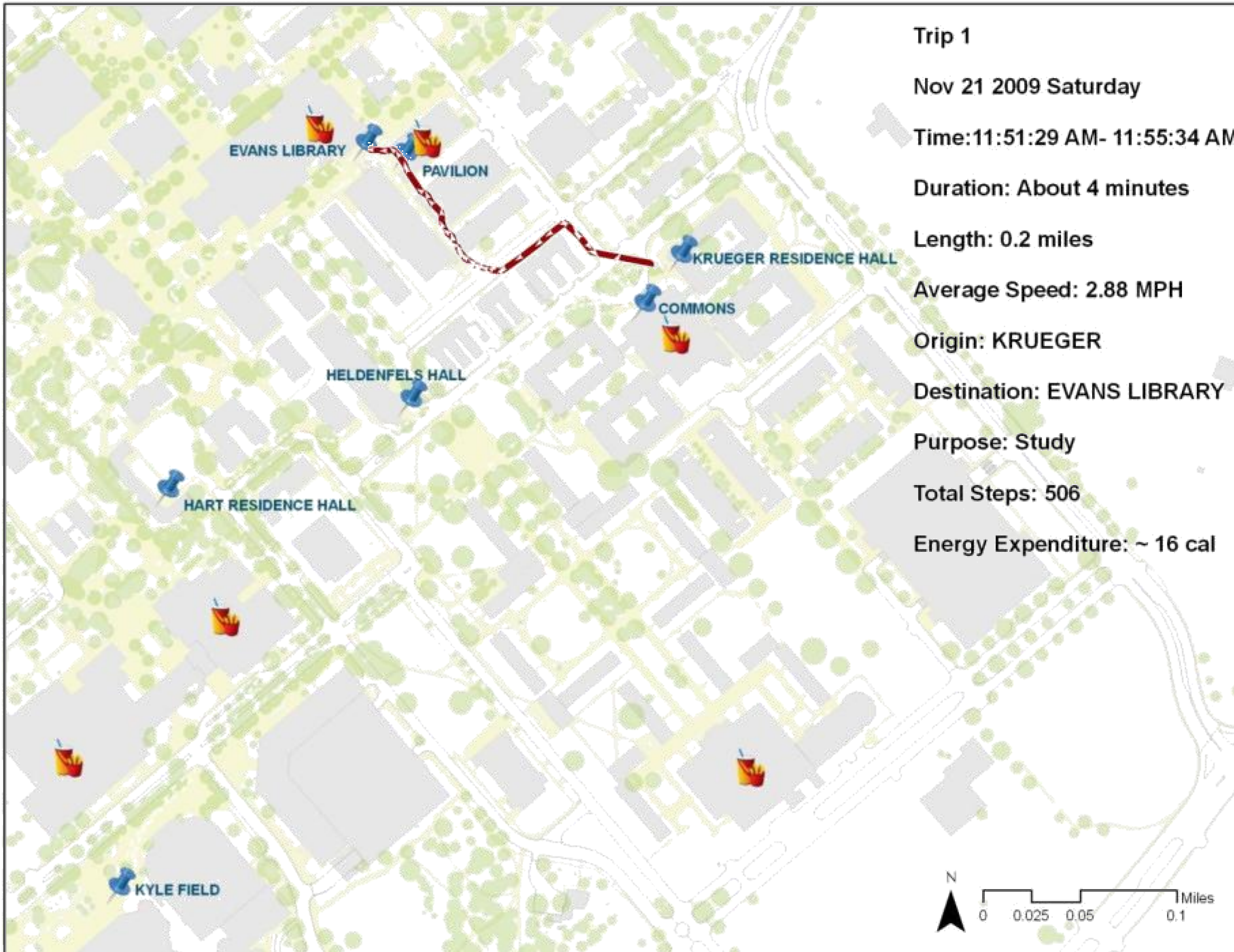
Files needed:
.GPX file (downloaded from the GPS unit)
.CSV file (downloaded from the Accelerometer unit)

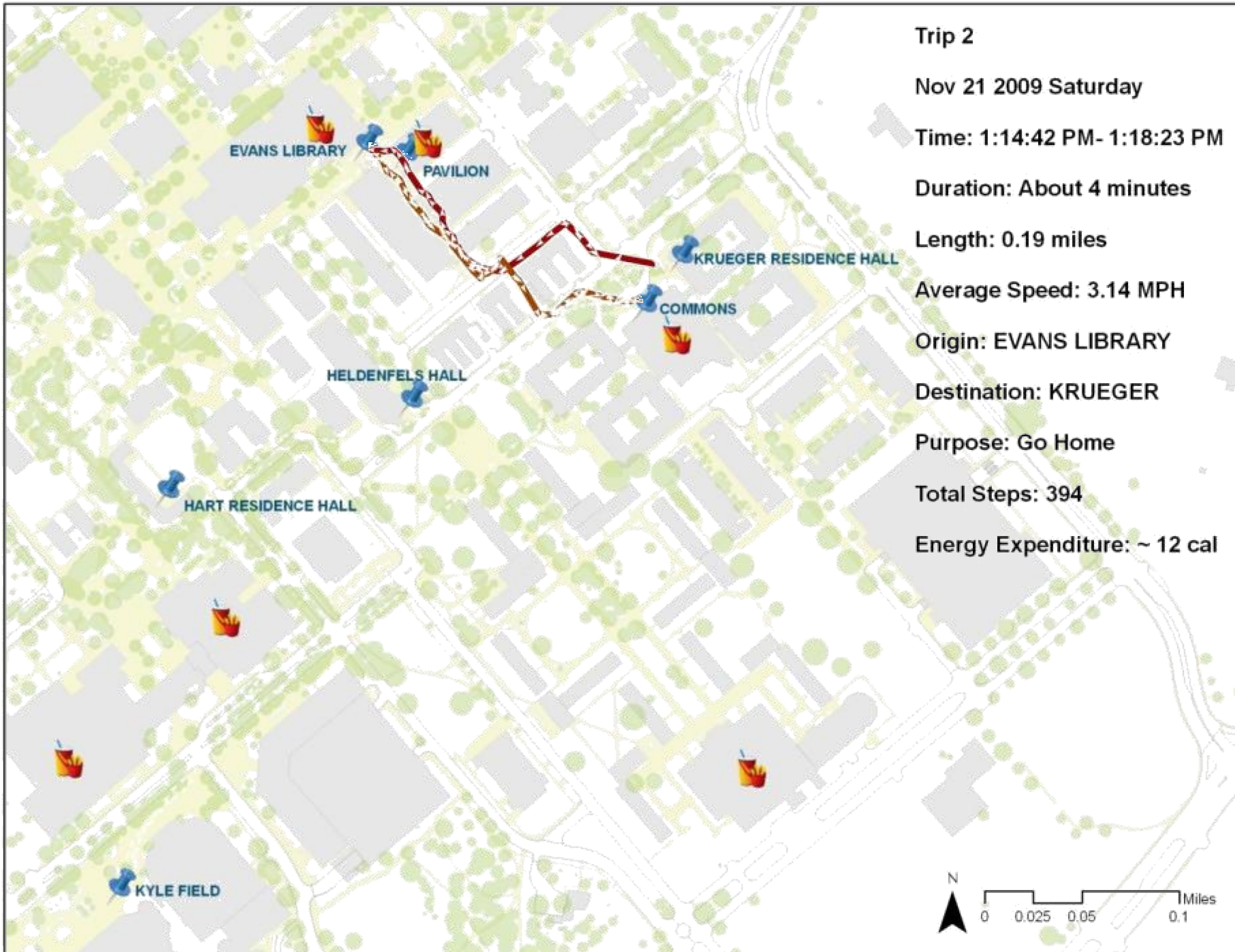
4. Classify the Synchronized data

REF: Troped et al. (2008). Prediction of activity mode with global positioning system and accelerometer data. Medicine & Science in Sports & Exercise, 40(5) 972-978.

- Route vs. destinations
- Modes (e.g. walking, driving) based on:
  - Speed (GPS)
  - Step count (Accelerometer)
  - Travel diary (if available)
- Individual Trips




Trip 1
Nov 21 2009 Saturday
Time:11:51:29 AM- 11:55:34 AM
Duration: About 4 minutes
Length: 0.2 miles
Average Speed: 2.88 MPH
Origin: KRUEGER
Destination: EVANS LIBRARY
Purpose: Study
Total Steps: 506
Energy Expenditure: ~ 16 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles



Trip 2

Nov 21 2009 Saturday

Time: 1:14:42 PM- 1:18:23 PM

Duration: About 4 minutes

Length: 0.19 miles

Average Speed: 3.14 MPH

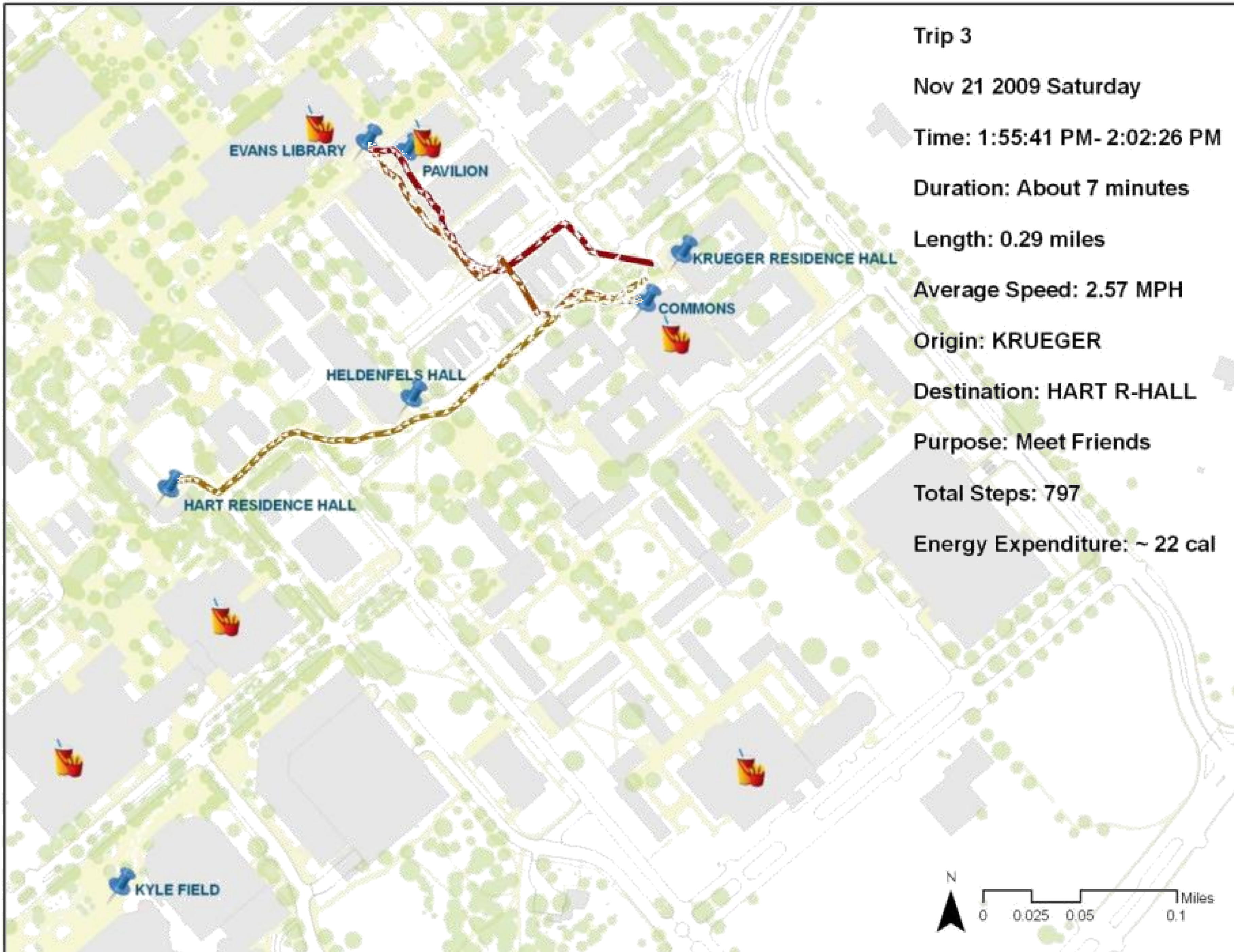
Origin: EVANS LIBRARY

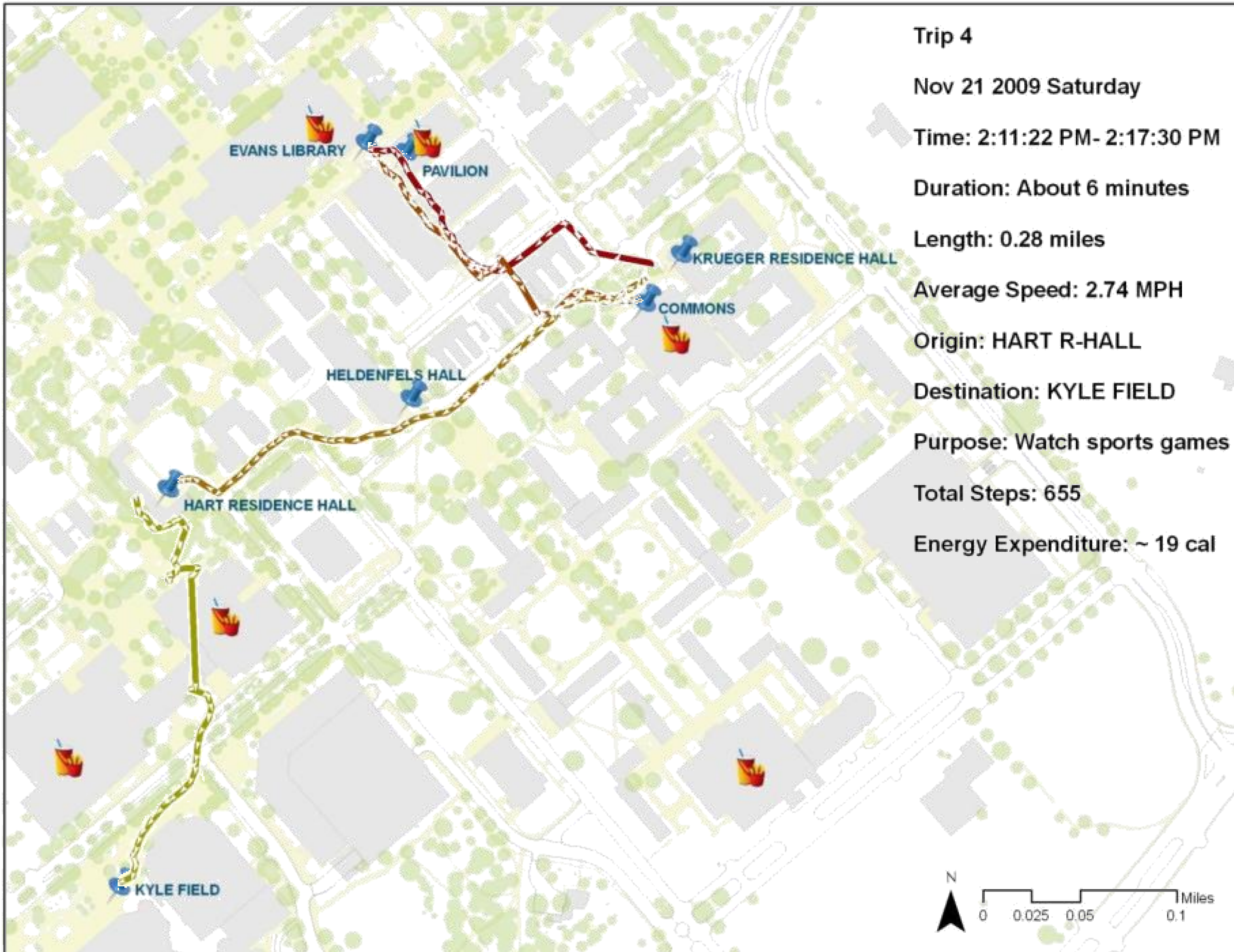
Destination: KRUEGER

Purpose: Go Home

Total Steps: 394

Energy Expenditure: ~ 12 cal


Trip 3
Nov 21 2009 Saturday
Time: 1:55:41 PM- 2:02:26 PM
Duration: About 7 minutes
Length: 0.29 miles
Average Speed: 2.57 MPH
Origin: KRUEGER
Destination: HART R-HALL
Purpose: Meet Friends
Total Steps: 797
Energy Expenditure: ~ 22 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles


Trip 4
Nov 21 2009 Saturday
Time: 2:11:22 PM- 2:17:30 PM
Duration: About 6 minutes
Length: 0.28 miles
Average Speed: 2.74 MPH
Origin: HART R-HALL
Destination: KYLE FIELD
Purpose: Watch sports games
Total Steps: 655
Energy Expenditure: ~ 19 cal
EVANS LIBRARY
PAVILION
KRUEGER RESIDENCE HALL
COMMONS
HELDENFELS HALL
HART RESIDENCE HALL
KYLE FIELD
N
0
0.025
0.05
0.1
Miles

Results: Participants

Age: **9.5** Years

Gender: **50.8%** Girl

Ethnicity/Race: **58.3%** Hispanic origin, 34.2% White

Economic Status: **50%** qualified for the free or reduced price lunch program

Results: Trip Summary

112 (85%) out of 132 participants with at least one valid home-to/from-school route identified

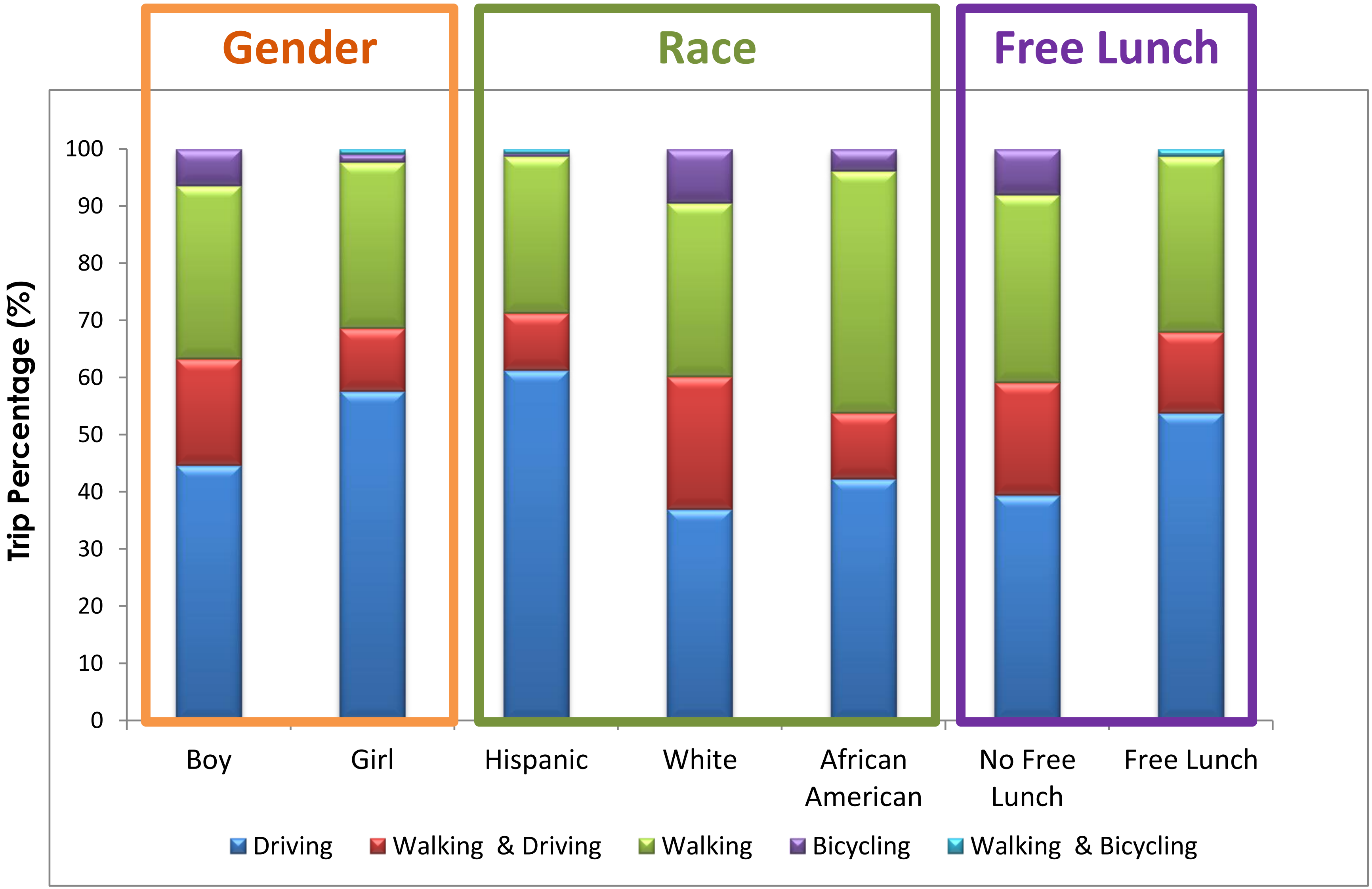
303 person-days & 579 trip segments extracted

Automobiles (private car and school bus): 61.4%
Walking: 34.9%
Bicycling: 3.7%

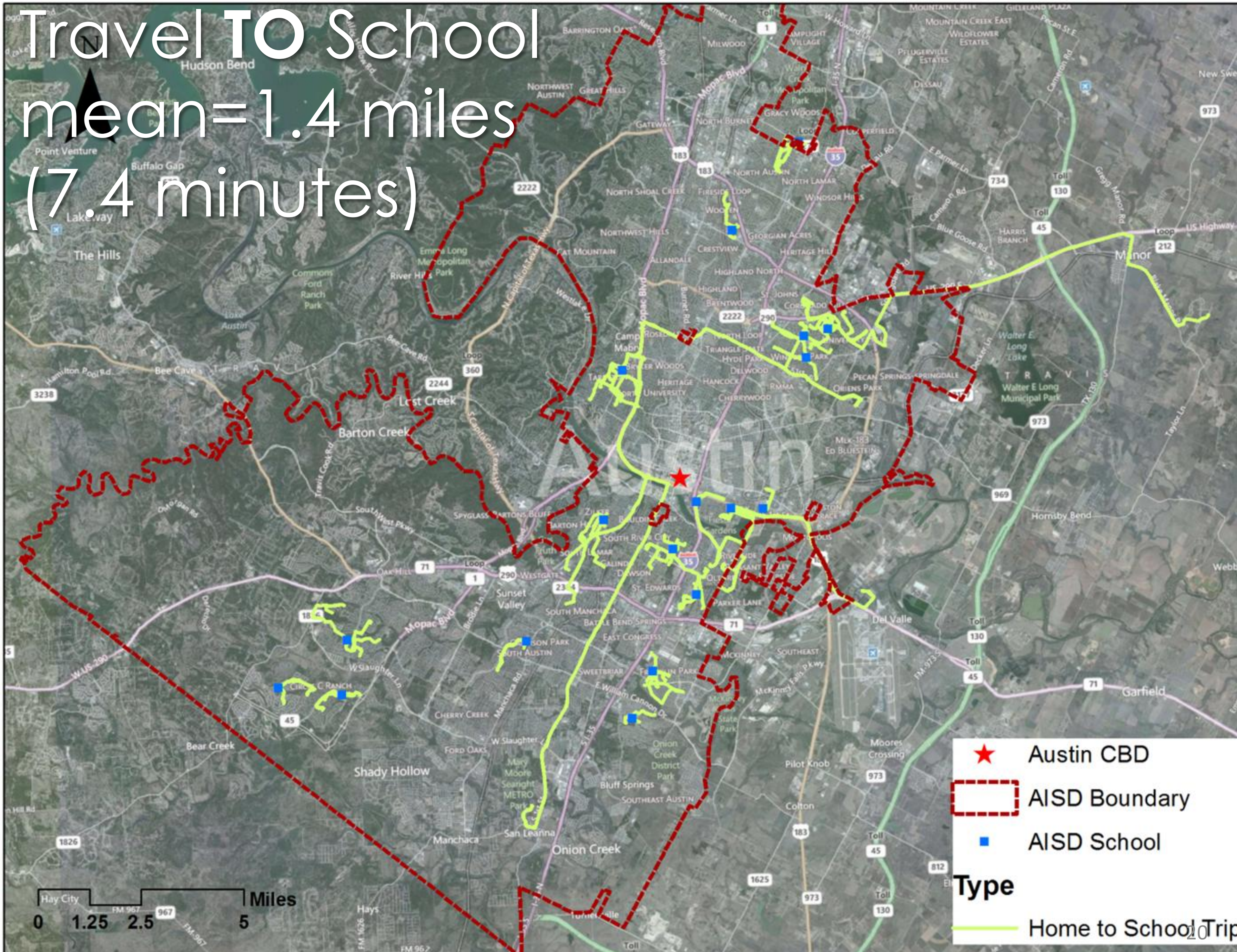
39% were chained trips

Chained trips: 1+ stops en route to/from school for other purposes (72% of chained trips were school-to-home trips)

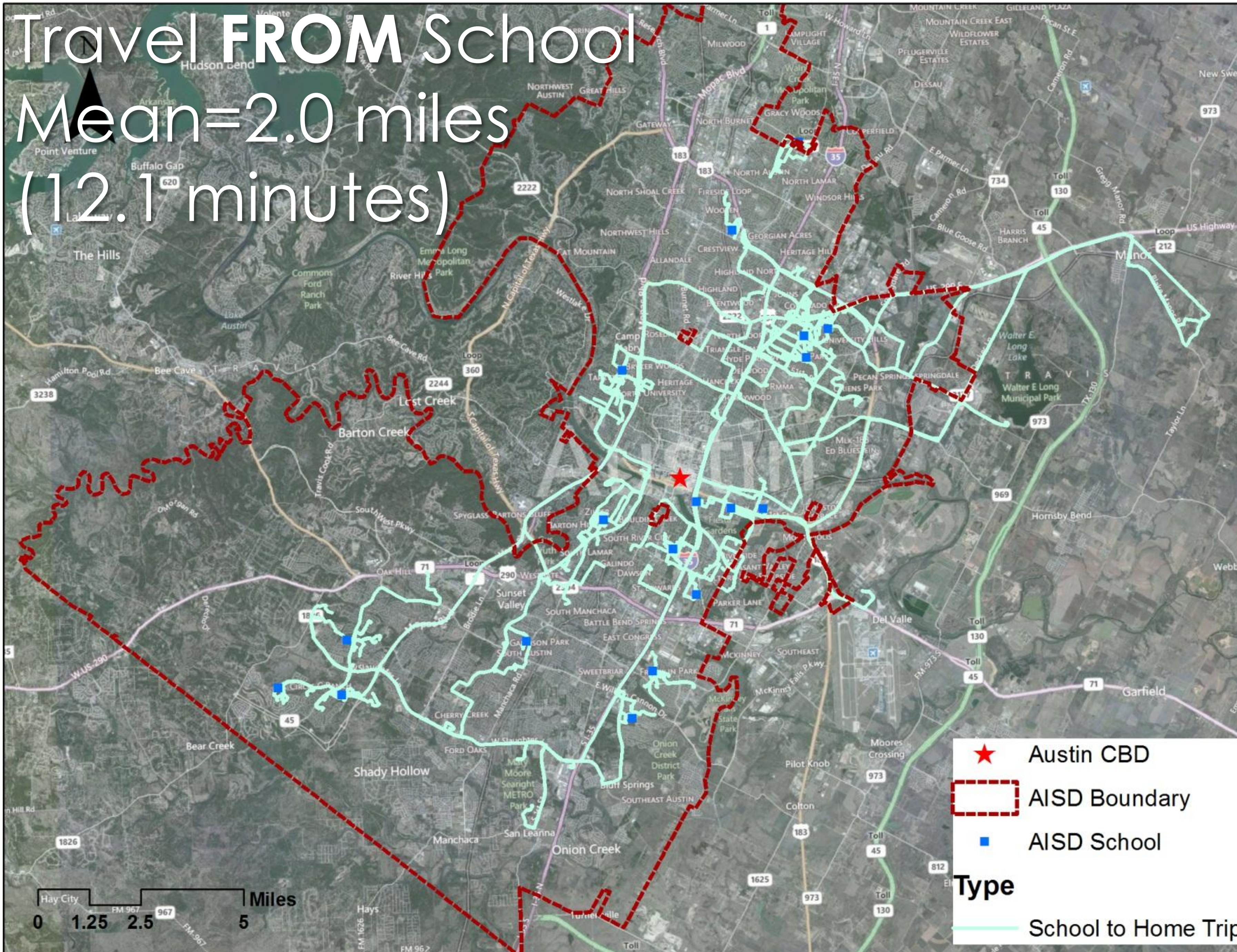
Results: Travel mode



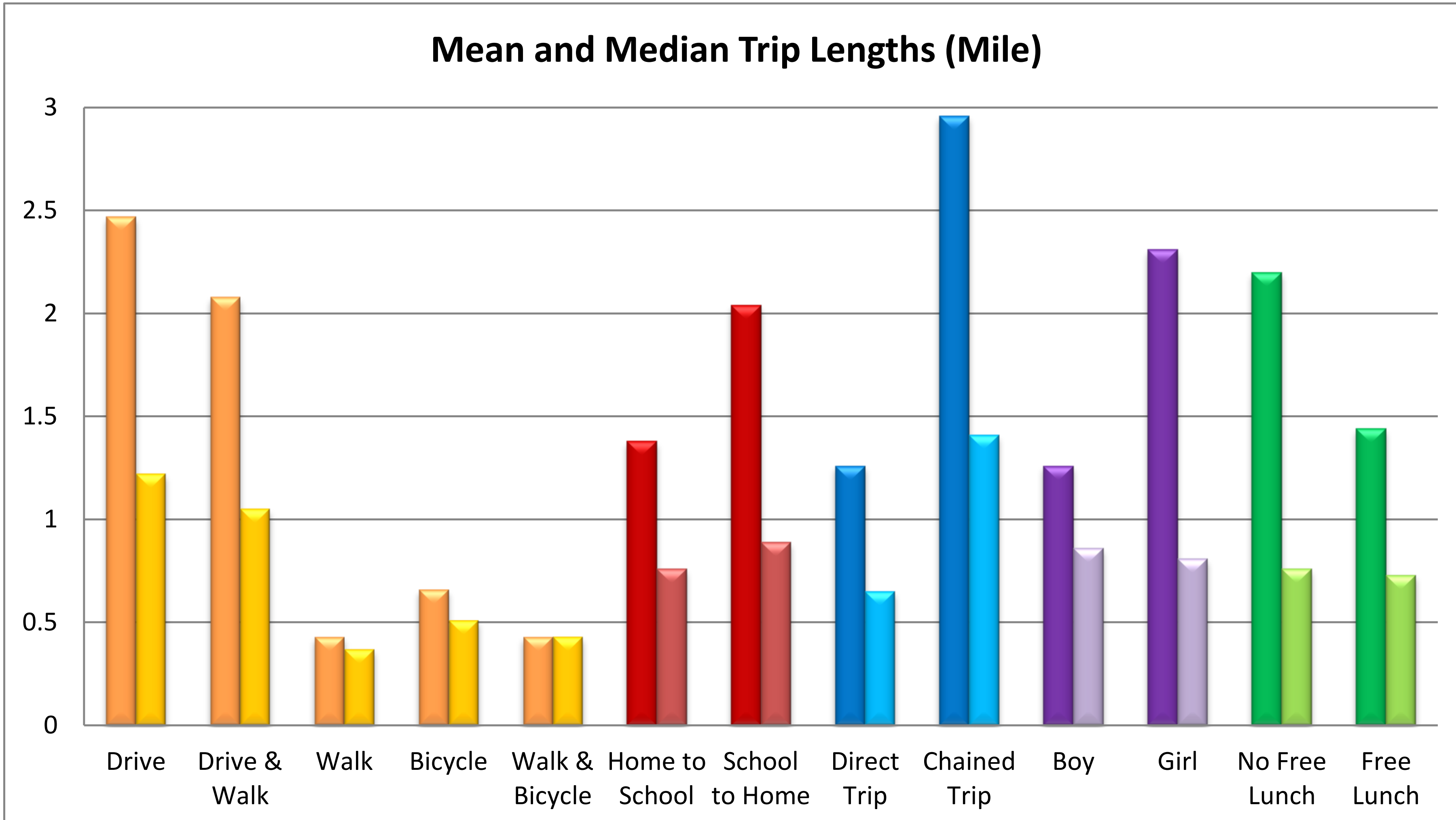
Travel **TO** School mean=1.4 miles (7.4 minutes)



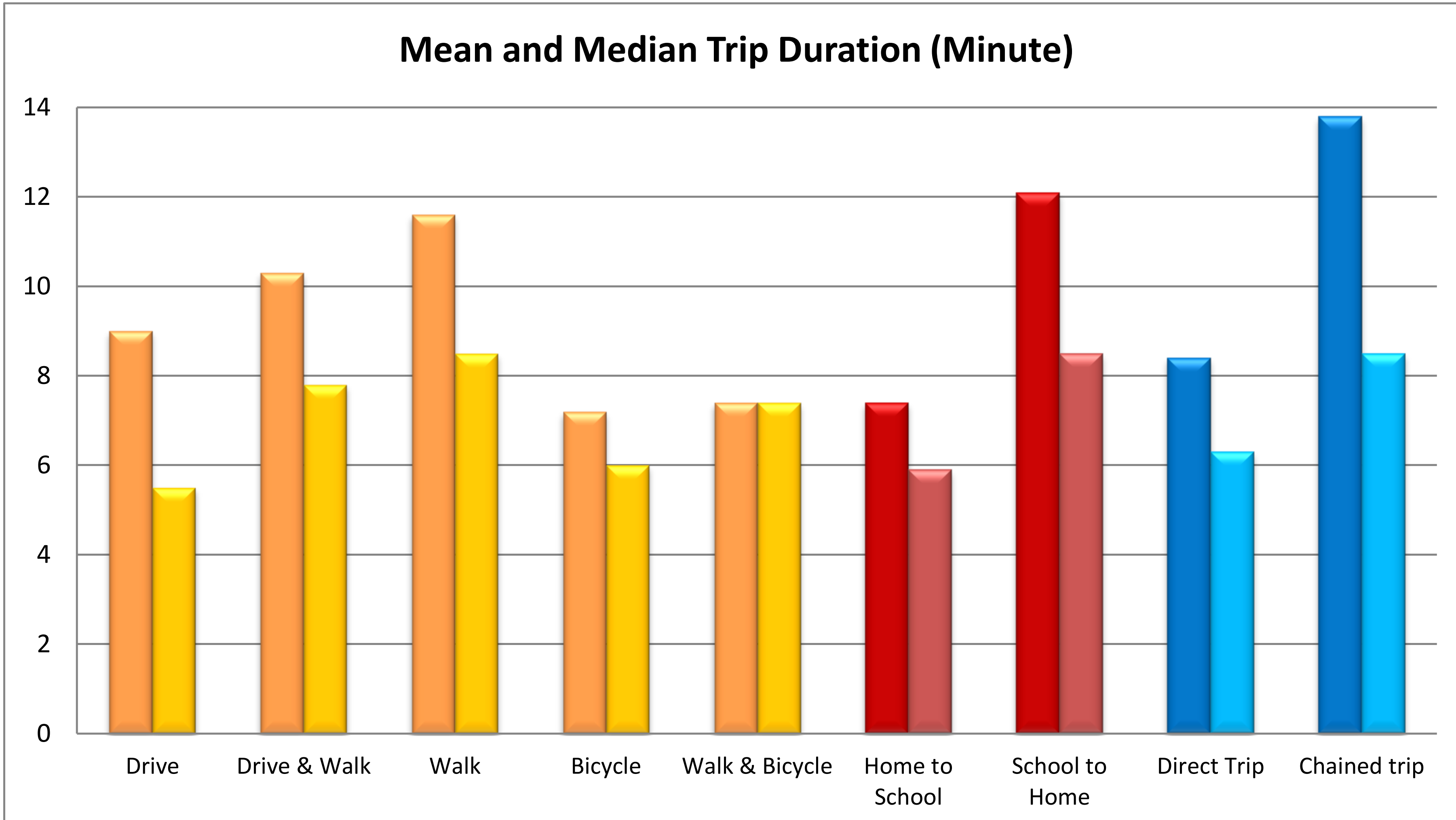
Travel **FROM** School Mean=2.0 miles (12.1 minutes)



Results: Trip Length

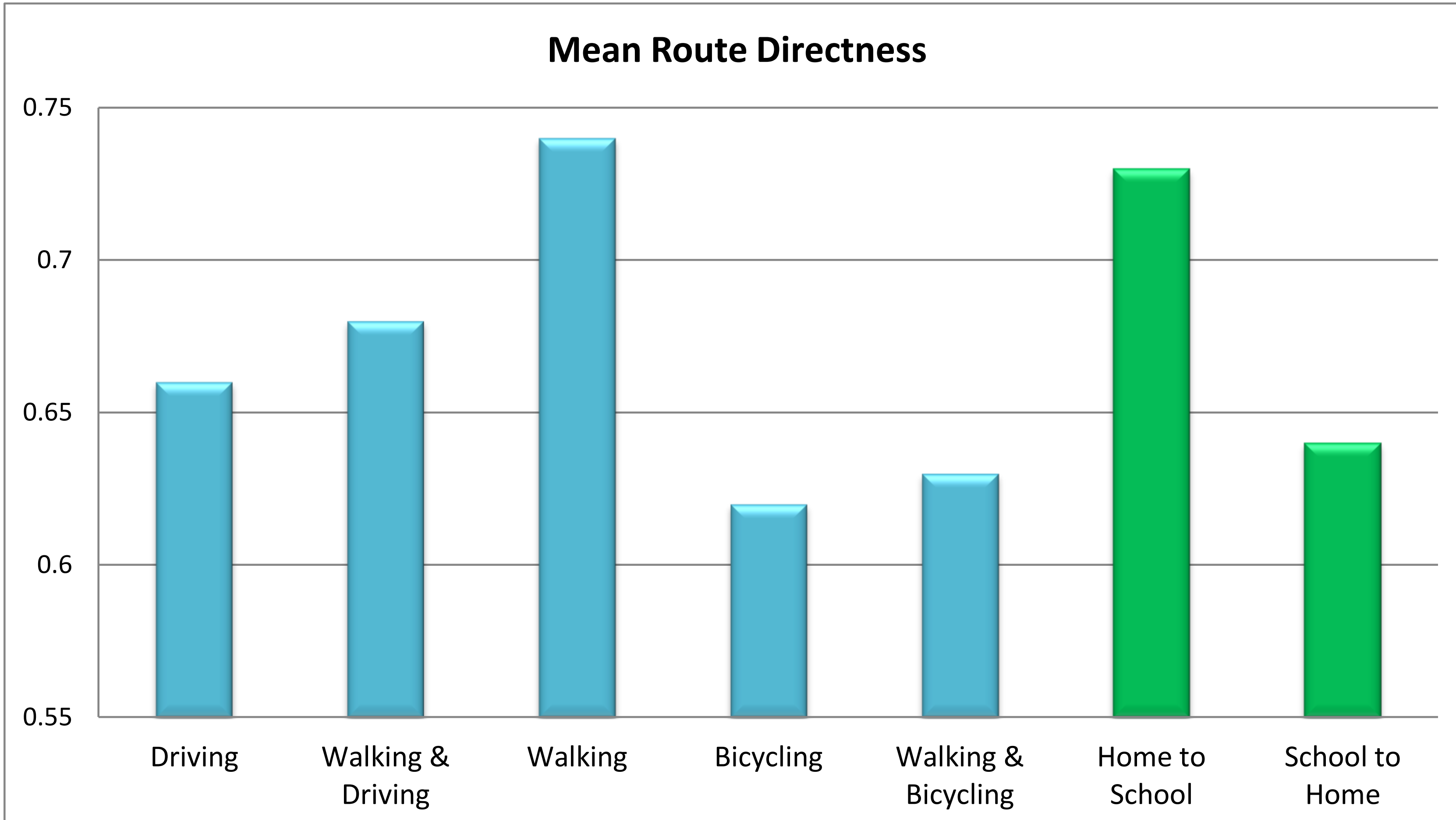


Results: Trip duration

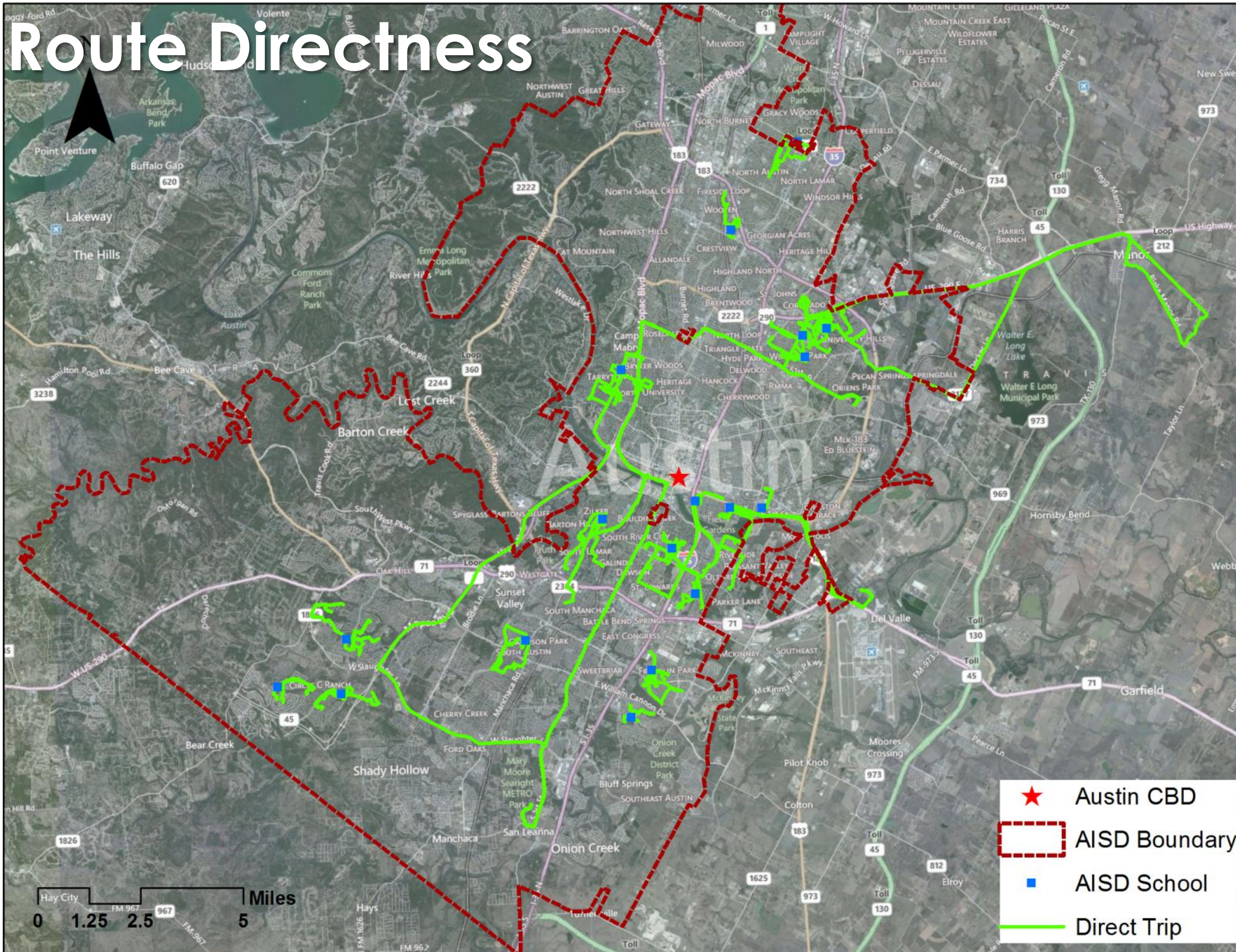


Results: Route Directness

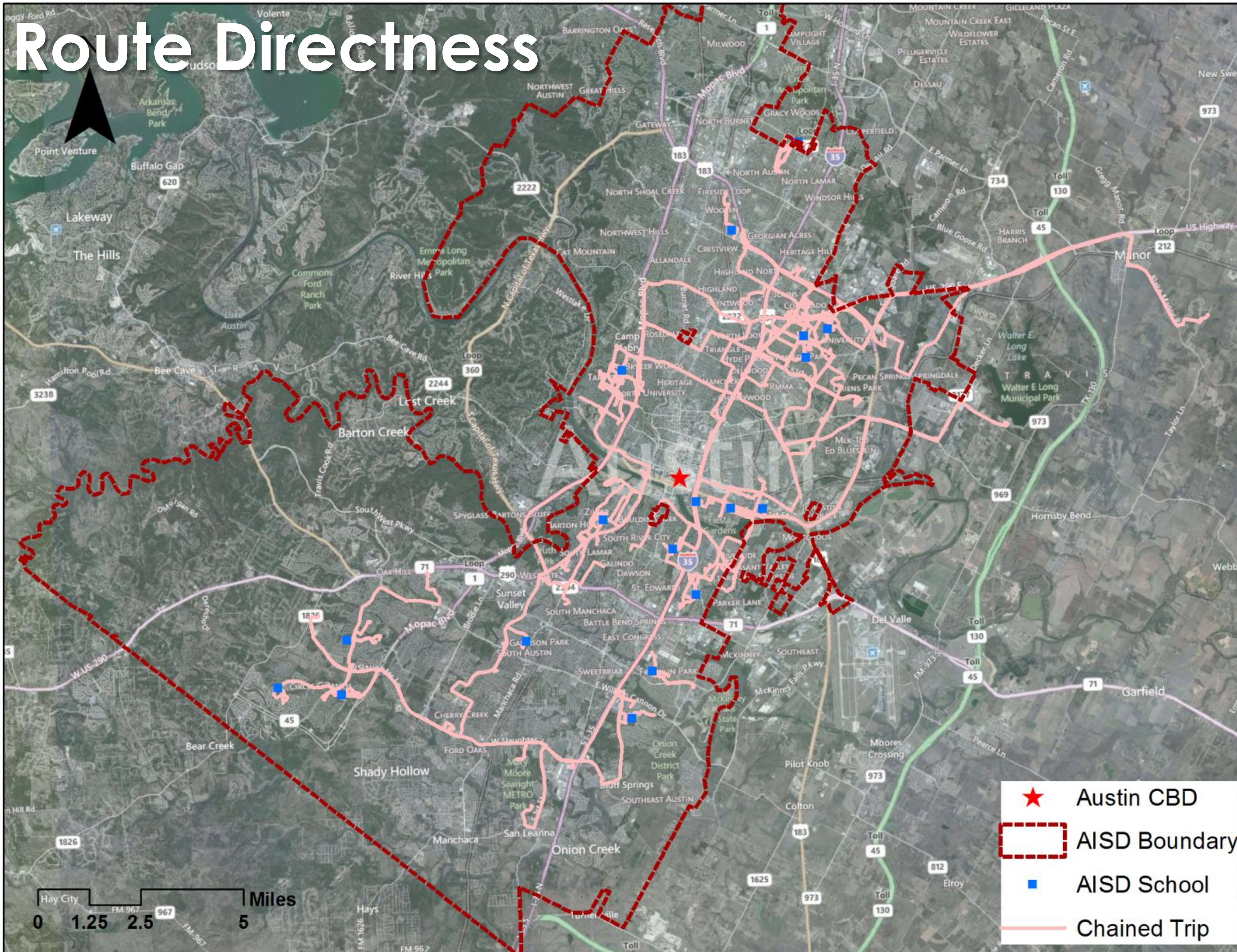
Route Directness = Direct (Straight) Distance / Actual Trip Length



Route Directness

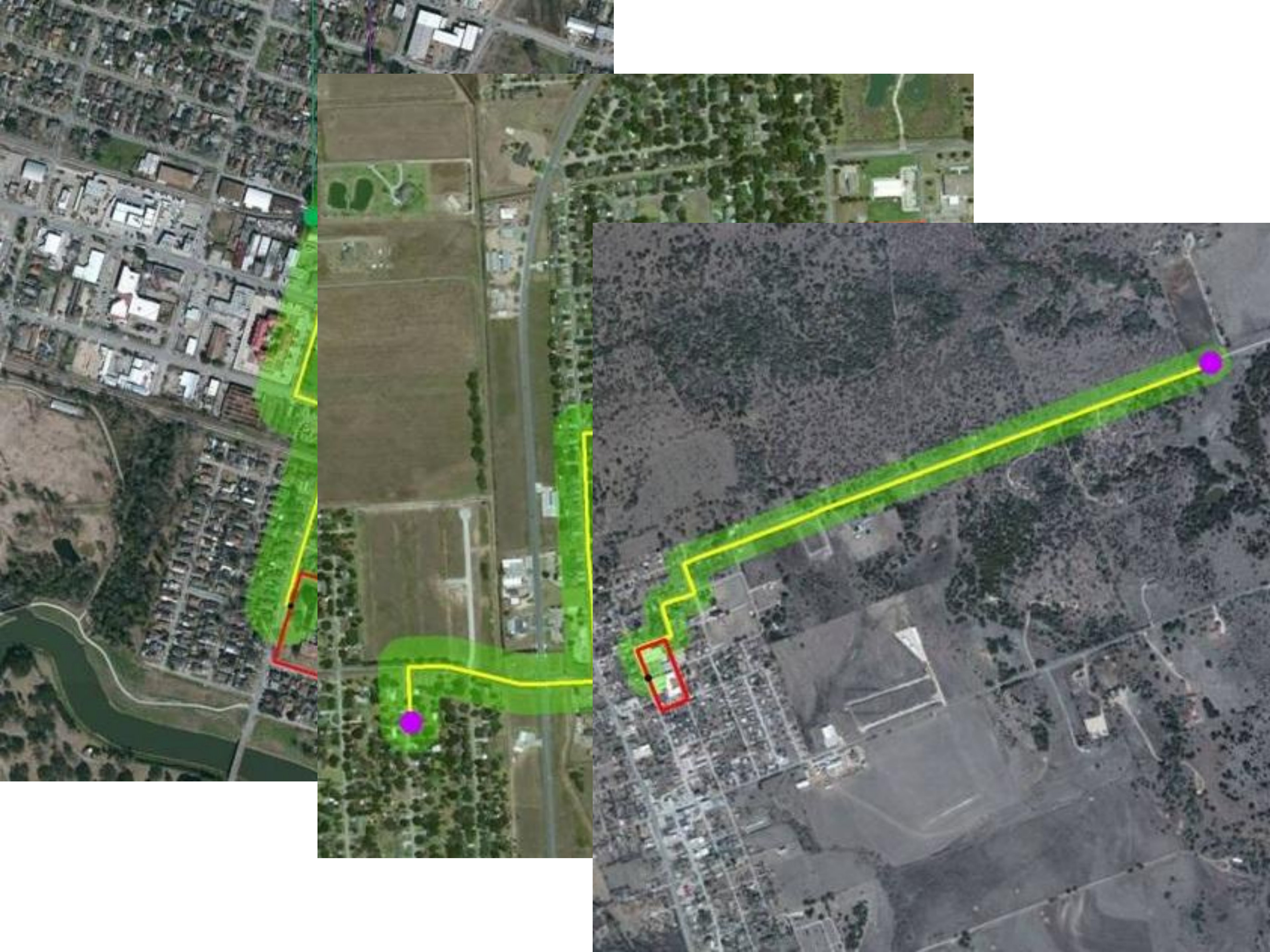


Route Directness

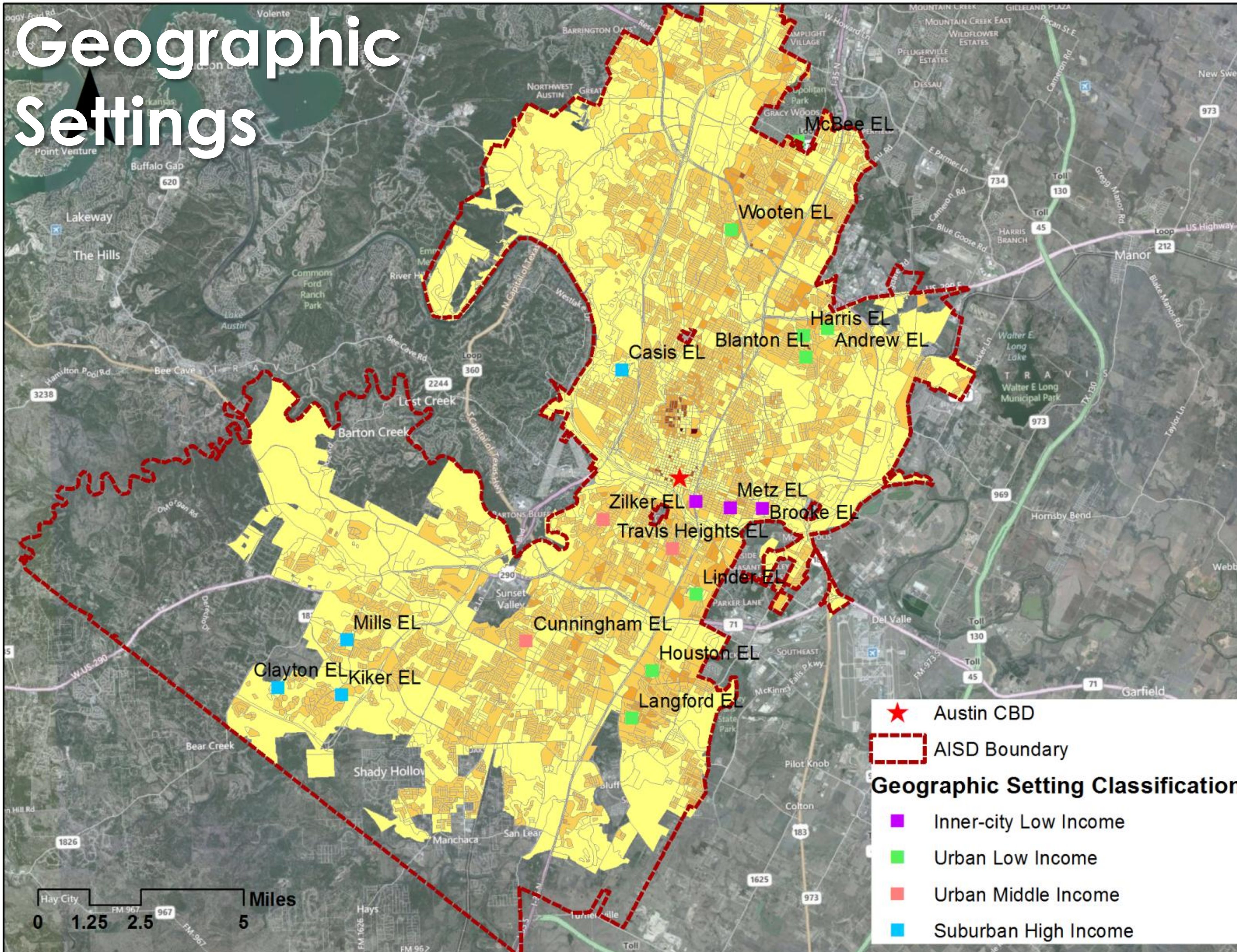


Results:
Geographic Settings

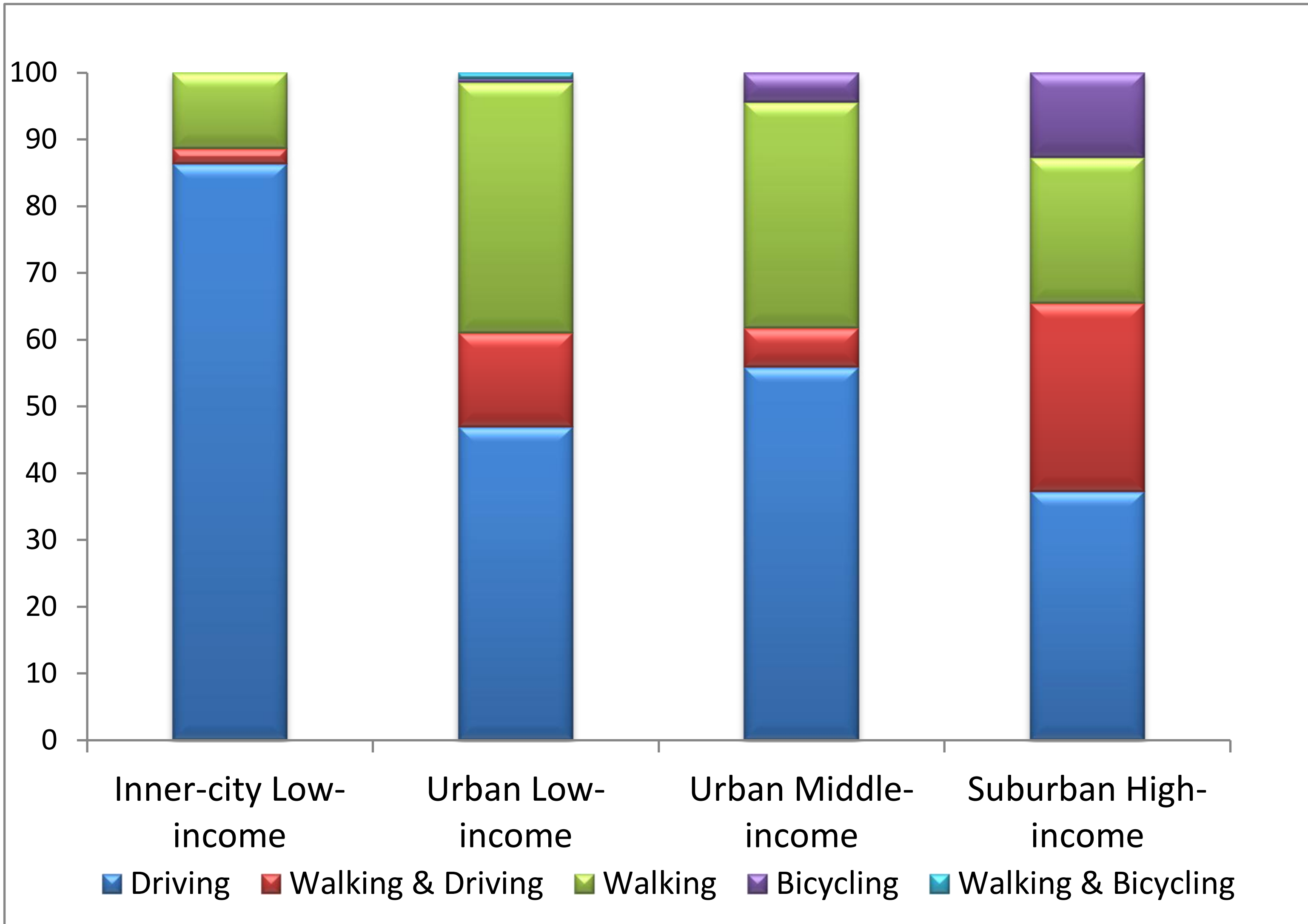
Geographic Setting Type (# of schools)	Population Density	Percentage of Hispanic	Median Household Income	Location Clustering
Inner-city low income (3)	Medium	High	Low	East
Urban low income (8)	High	High	Low	Northeast & Southeast
Urban middle income (3)	Medium	Medium	Medium	South
Sub-urban high income (4)	Low	Low	High	West



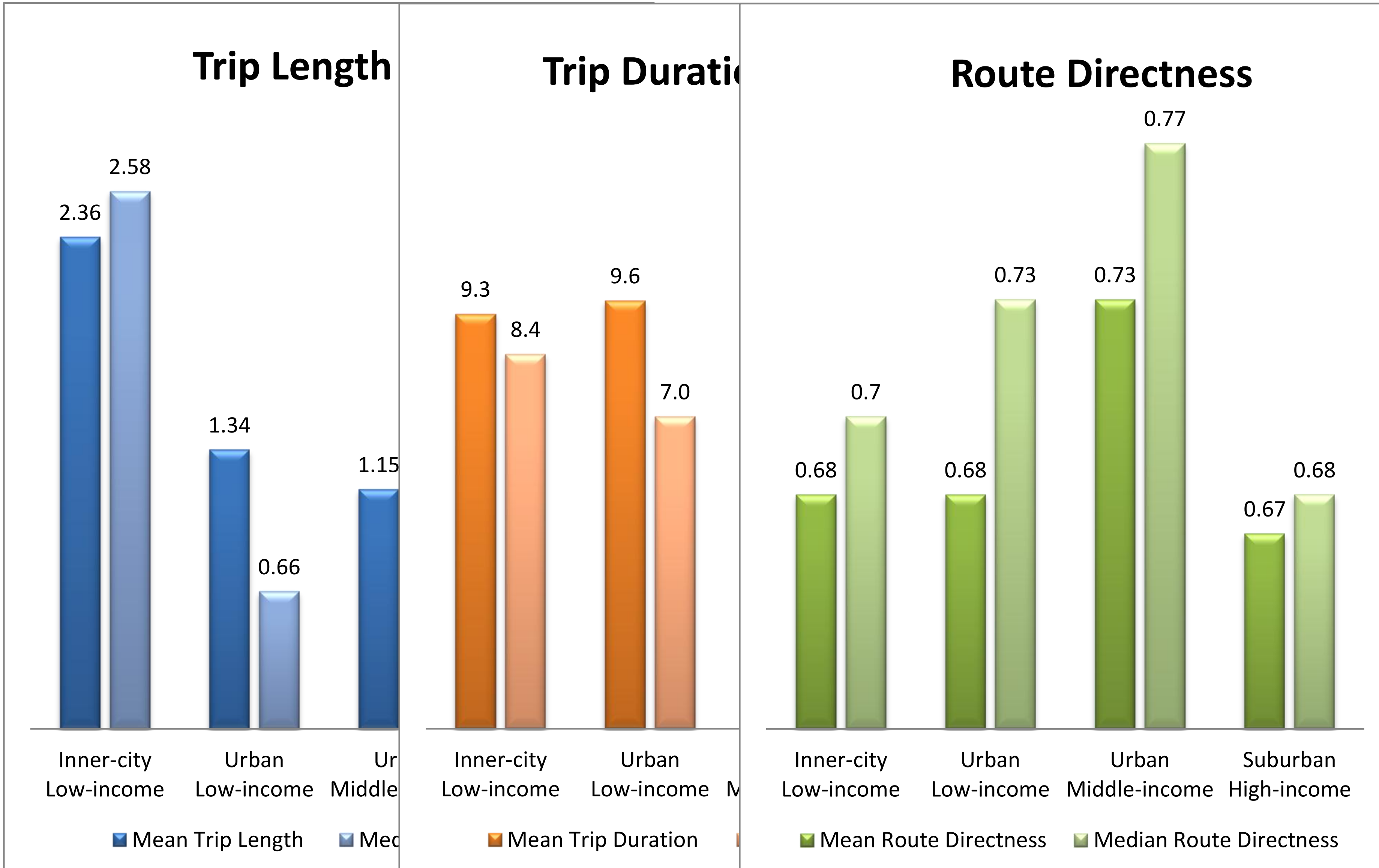
Geographic Settings



Results: Geographic Settings



Results: Geographic Settings



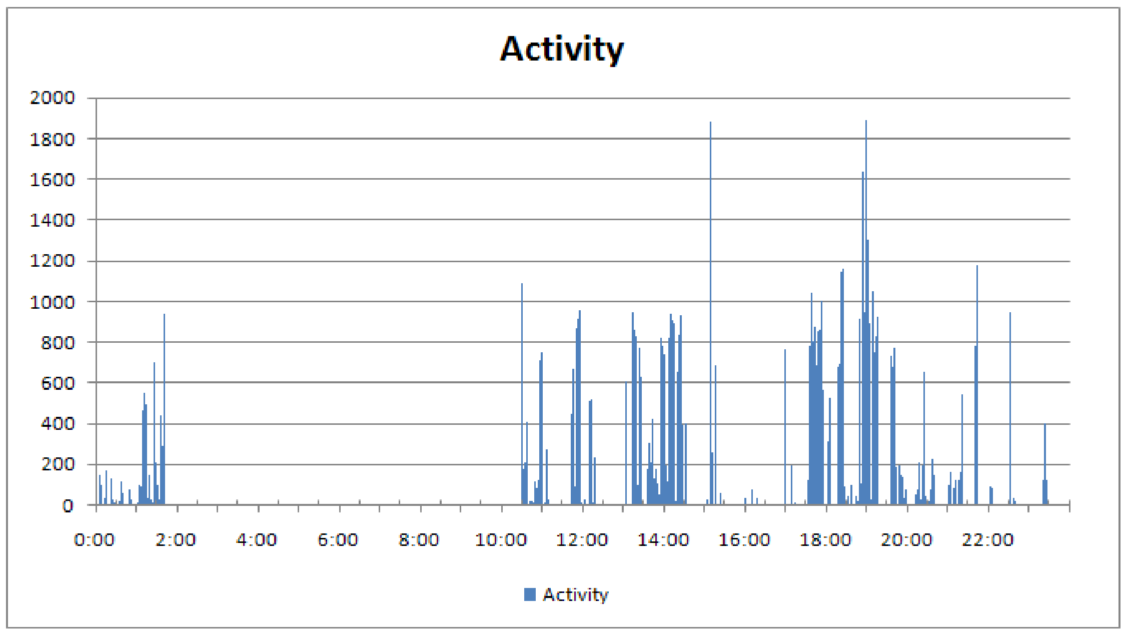
Results: Physical Activity

Three ways to compare daily MVPA:

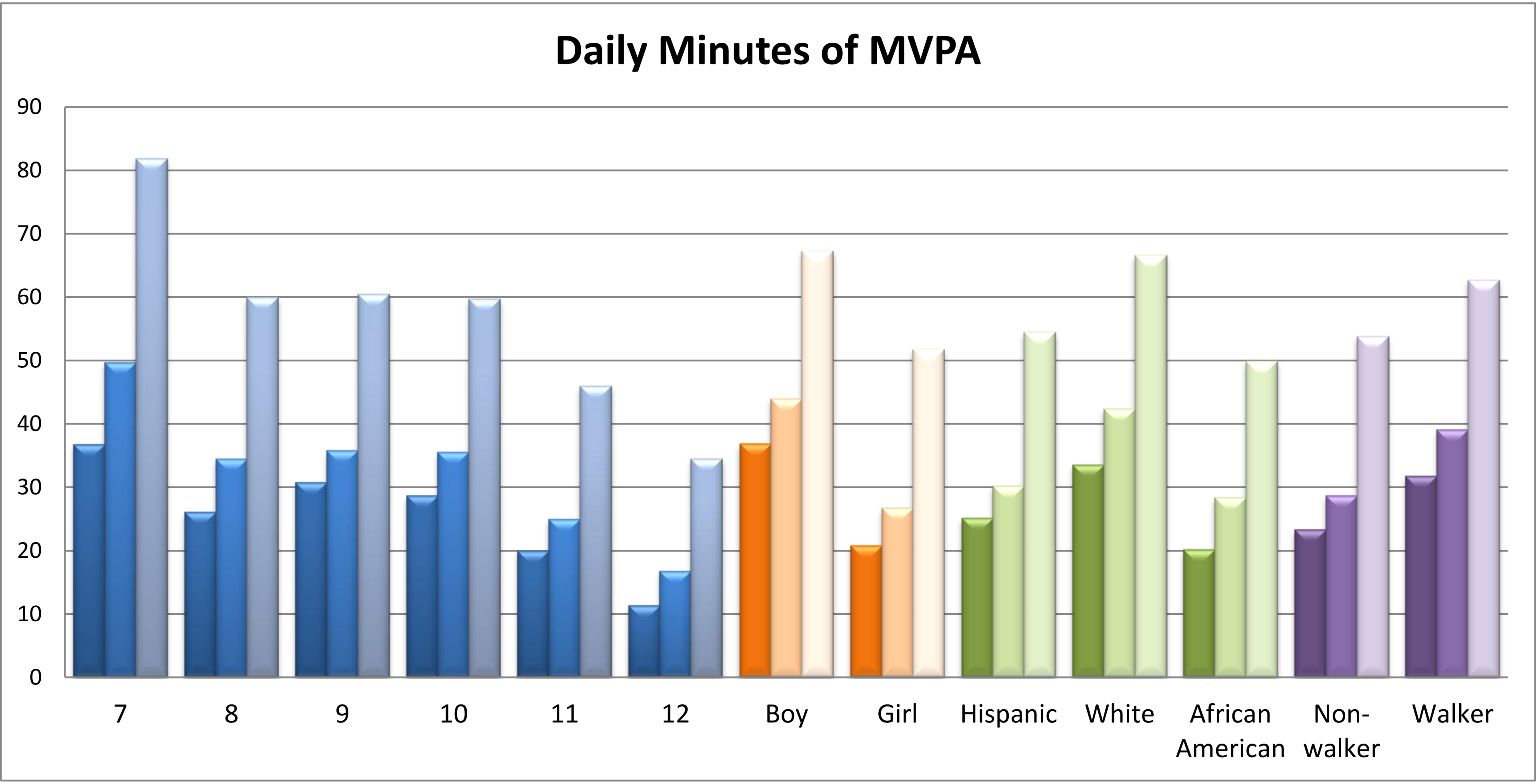
a. Minutes of MVPA 1
   Thresholds: bout length - 5 minutes; tolerance - 1 minute

b. Minutes of MVPA 2
   Thresholds: bout length - 10 minutes; tolerance - 2 minutes

b. Daily accumulated minutes of MVPA
   No bout threshold



Results: Physical Activity



Results: Physical Activity

Average daily MVPA was **34.6 minutes**

Walkers had **10 more minutes** of daily MVPA than non-walkers (39.1 vs. 28.7)

The average contribution in percentage from active travel modes to the total daily MVPA was **33.5%**

More sedentary participants had a greater proportion of their MVPA accounted for by active school travels.
For example, a student with 10 minutes of total daily MVPA had 7 minutes (70%) from school travels, while a student with 1 hour of daily MVPA had 9 minutes (15%) from school travels.

Conclusion

- Continued decline in PA with **age** among elementary school students

→ **intervention at younger age**

- 0.5 miles confirmed as feasible distance for walking (and also likely bicycling)

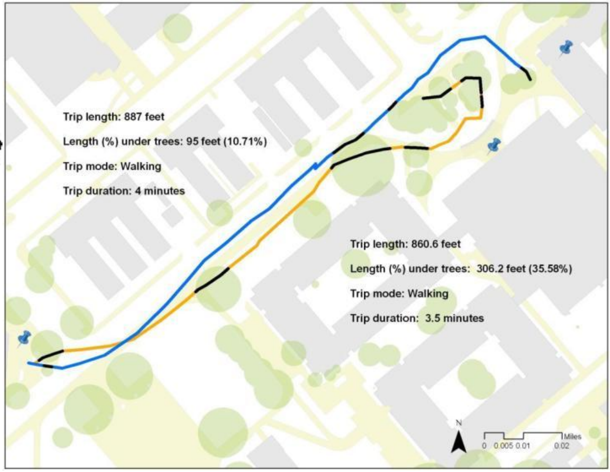
→ **intervention efforts targeting students living within 0.5 mile**

Conclusion

- Boys (vs. girls), White and African American (vs. Hispanic), and high SES (vs. low SES) with higher share of **walking to school (WTS)**
- Boys (vs. girls), White (vs. Hispanic, African American), high SES (vs. low SES) and walkers (vs. non-walkers) with more **PA**
- More **sedentary** children had a greater proportion of their MVPA accounted for by active school travels.
- Significant **variations** in WTS and PA across different **settings** and **income** levels

→ **Interventions for WTS vs. PA; currently sedentary vs. active children; by different environmental contexts**

Discussions



- Accuracy and completeness of GPS-accelerometer data for children (85% with at least 1 valid school trip extracted from 7 days of wearing).
- Further analyses to include detailed spatial analyses of the GPS-accelerometer data with GIS and audit data.
- Travel behavior and PA variations by neighborhood/school contexts and the need for context-specific interventions; but challenges in classifying heterogeneous contexts into meaningful groups.
- Inner-city schools and schools close to major employment centers with longer travel distance primarily due to parents' work locations (residential vs. work locations/populations)

Design Research for Active Living

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WELCOME TO DESIGN RESEARCH FOR ACTIVE LIVING AT TEXAS A&M!

The Design Research for Active Living group is devoted to interdisciplinary research aimed at linking elements of the built environment with human health behaviors and outcomes. We believe that the homes, neighborhoods, cities and regions in which we live, work, study and play form an important health infrastructure that can promote or hinder good health. Made up of faculty members and students from Texas A&M University, our teams focus on identifying the specific and modifiable attributes of the built environment that can contribute to active and healthy living for all, especially vulnerable populations such as children, minorities and older adults. Toward this end, we conduct research projects examining people-environment relationships from the smaller architectural scale to the larger neighborhood and regional scales. Our work also is focused on multiple perspectives, from practitioners to policy-makers perspective, and from a people-oriented view to an environment-oriented view. Finally, we are committed to advancing theoretical and methodological approaches to better characterize the built environment for research, practice, and intervention purposes.

RESEARCH HIGHLIGHT

The "Whys" and "Why Nots" of Active Living: Barriers and Motivators among HighRisk Children.

This research examines multi-level natural and virtual experiments to identify specific interventions effective in promoting walking and physical activity and reducing obesity ... *more*

Safety, Health, and Equity for Active School Transportation: Interactions among Multi- Level Factors and Specific Needs of Low-Income Hispanic Children.

This research aims: 1) to examine the mediating and moderating factors in the relationship between objective physical environment and active school transportation; ... *more*

Institute for Obesity Research and Program Evaluation, Texas A&M University; and College Research and Interdisciplinary Council, College of Architecture, Texas A&M University.

This pilot study is to explore the impact of food and physical activity environments where students live, work and study onenergy expenditure. It will also compare diet and physical... *more*

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