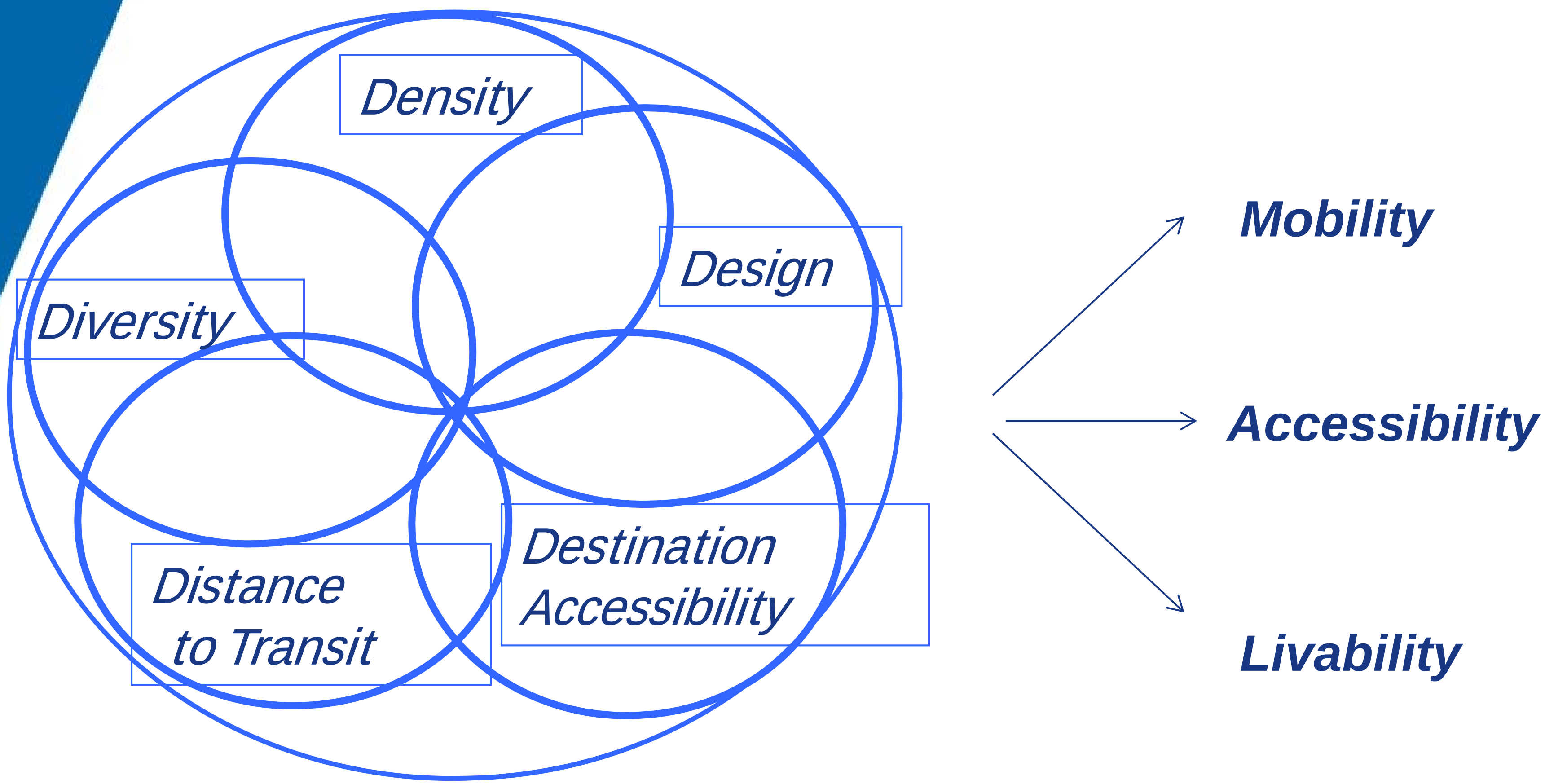
Trip and Parking Generation at TODs

Reid Ewing, Guang Tian, and Torrey Lyons
Department of City and Metropolitan Planning
University of Utah

Preston Stinger
Fehr & Peers

Rachel Weinberger, Ben Kaufman, and Kevin Shivley
Nelson\Nygaard Consulting Associates

5Ds of Compact Development



Transportation
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CrossMark

Trip and parking generation at transit-oriented developments: a case study of Redmond TOD, Seattle region

Guang Tian[1] · Reid Ewing[1] · Rachel Weinberger[2] · Kevin Shively[2] · Preston Stinger[3] · Shima Hamidi[4]

Abstract The decision on how best to allocate land around transi
topic, with transit officials often opting for park-and-ride lots ove
multifamily housing, office, and retail organized into transit-o
(TODs). In this study, we identify the ten best self-contained TOD
United States based on seven criteria: dense, mixed-use, pedestria

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Research Paper

Trip and parking generation at transit-oriented developments: Five US case studies

CrossMark

Reid Ewing*, Guang Tian, Torrey Lyons, Kathryn Terzano

College of Architecture+Planning, 220 AAC, University of Utah, 375S 1530 E, Salt Lake City, UT 84112, United States

HIGHLIGHTS

- Parking demand at the five TODs is generally less than half the US guideline.
- Trip generation at the five TODs is generally less than half the US guideline.
- Automobile mode shares at the five US TODs are as low as one quarter of all trips.
- Results suggest the potential for significant savings in TOD developments.
- Guidelines are provided for using study results in TOD planning.

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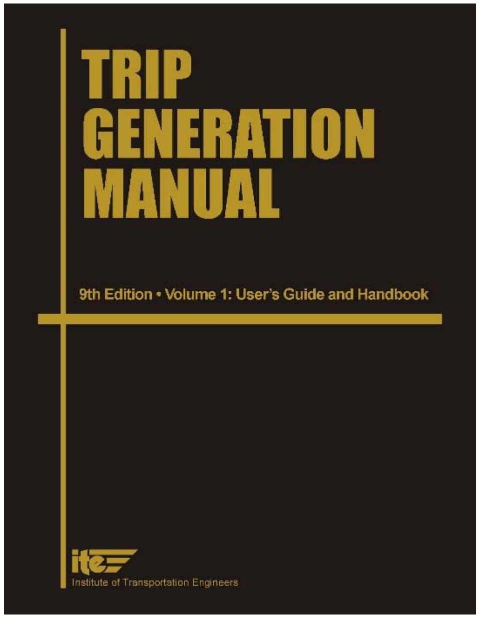
ABSTRACT

Guidelines for trip and parking generation in the United States come mainly from the Institute of Transportation Engineers (ITE). However, their trip and parking manuals focus on suburban locations with limited transit and pedestrian access. This study aims to determine how many fewer vehicle trips are generated at transit-oriented developments (TODs), and how much less parking is required at TODs, than ITE guidelines would suggest.

Absent Hard Numbers

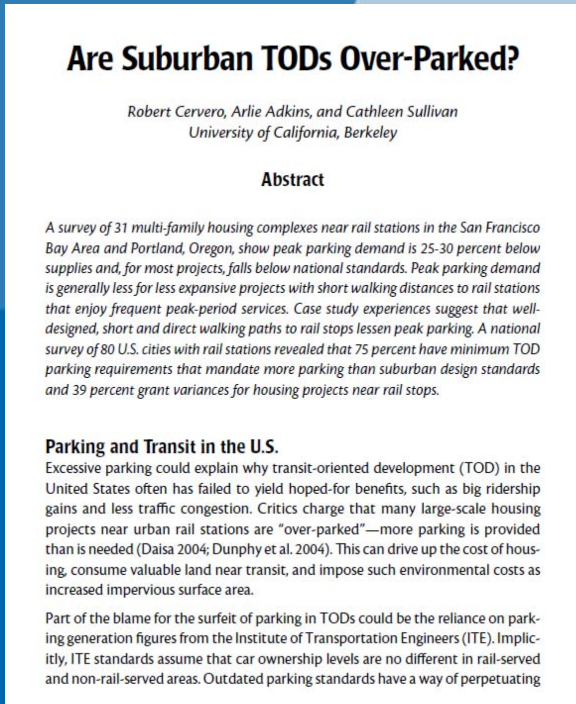
- Officials usually assume that TODs require the same number of parking spaces as conventional development and that transit stations require the same number of park-and-ride spaces as non-TOD stations.



Not Applicable to TODs

- "Data were primarily at suburban locations having little or no transit services, nearby pedestrian amenities, or travel demand management (TDM) programs." ITE Trip Generation Manual

- "Primarily isolated, suburban sites" ITE Parking Generation



Are Suburban TODs Over-Parked?

Robert Cervero, Arlie Adkins, and Cathleen Sullivan
University of California, Berkeley

Abstract

A survey of 31 multi-family housing complexes near rail stations in the San Francisco Bay Area and Portland, Oregon, show peak parking demand is 25-30 percent below supplies and, for most projects, falls below national standards. Peak parking demand is generally less for less expansive projects with short walking distances to rail stations that enjoy frequent peak-period services. Case study experiences suggest that well-designed, short and direct walking paths to rail stops lessen peak parking. A national survey of 80 U.S. cities with rail stations revealed that 75 percent have minimum TOD parking requirements that mandate more parking than suburban design standards and 39 percent grant variances for housing projects near rail stops.

Parking and Transit in the U.S.

Excessive parking could explain why transit-oriented development (TOD) in the United States often has failed to yield hoped-for benefits, such as big ridership gains and less traffic congestion. Critics charge that many large-scale housing projects near urban rail stations are "over-parked"—more parking is provided than is needed (Daisa 2004; Dunphy et al. 2004). This can drive up the cost of housing, consume valuable land near transit, and impose such environmental costs as increased impervious surface area.

Part of the blame for the surfeit of parking in TODs could be the reliance on parking generation figures from the Institute of Transportation Engineers (ITE). Implicitly, ITE standards assume that car ownership levels are no different in rail-served and non-rail-served areas. Outdated parking standards have a way of perpetuating

In Literature

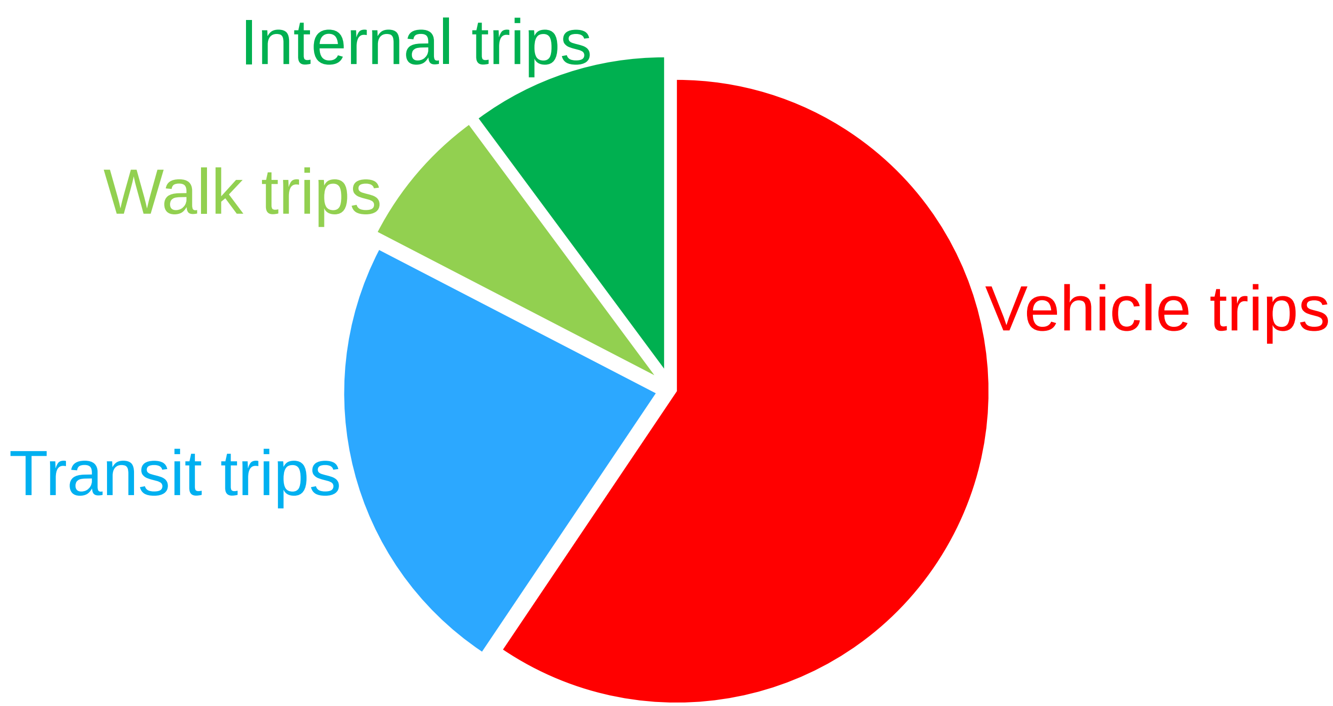
The average trip generation rate in areas with TOD is well below the trip generation rate from the ITE report (*Arrington & Cervero 2008; Cervero & Arrington 2008; Cervero et al. 2004*).

There are a few studies of vehicle trip generation (*Arrington & Cervero, 2008; Cervero & Arrington, 2008; Zamir et al. 2014*) at multifamily developments near transit. There is only one study of vehicle trip generation at TODs (defined as mixed-use developments – Handy et al. 2013). The question of how much vehicle trip reduction occurs with TOD is largely unexplored in the literature.

By comparing parking generation rates for housing projects near rail stops with parking supplies and with ITE's parking generation rates, (*Cervero et al. 2010*) found there is an **oversupply** of parking at TODs, sometimes by as much as 25-30 percent.

Research Question

Much of the travel demand is captured internally or satisfied by alternate modes



TOD Definition

TODs are widely defined as compact, mixed-use developments with high-quality walking environments near transit facilities (*ITE 2004, pp. 5-7; Jacobson & Forsyth 2008; Renne 2009*).

For our purposes, TODs are developed by a single developer under a master development plan, and can also include a clustering of development projects near transit facilities that are developed by one or more developers pursuant to a master development plan.

Dense

Mixed use

Pedestrian-friendly

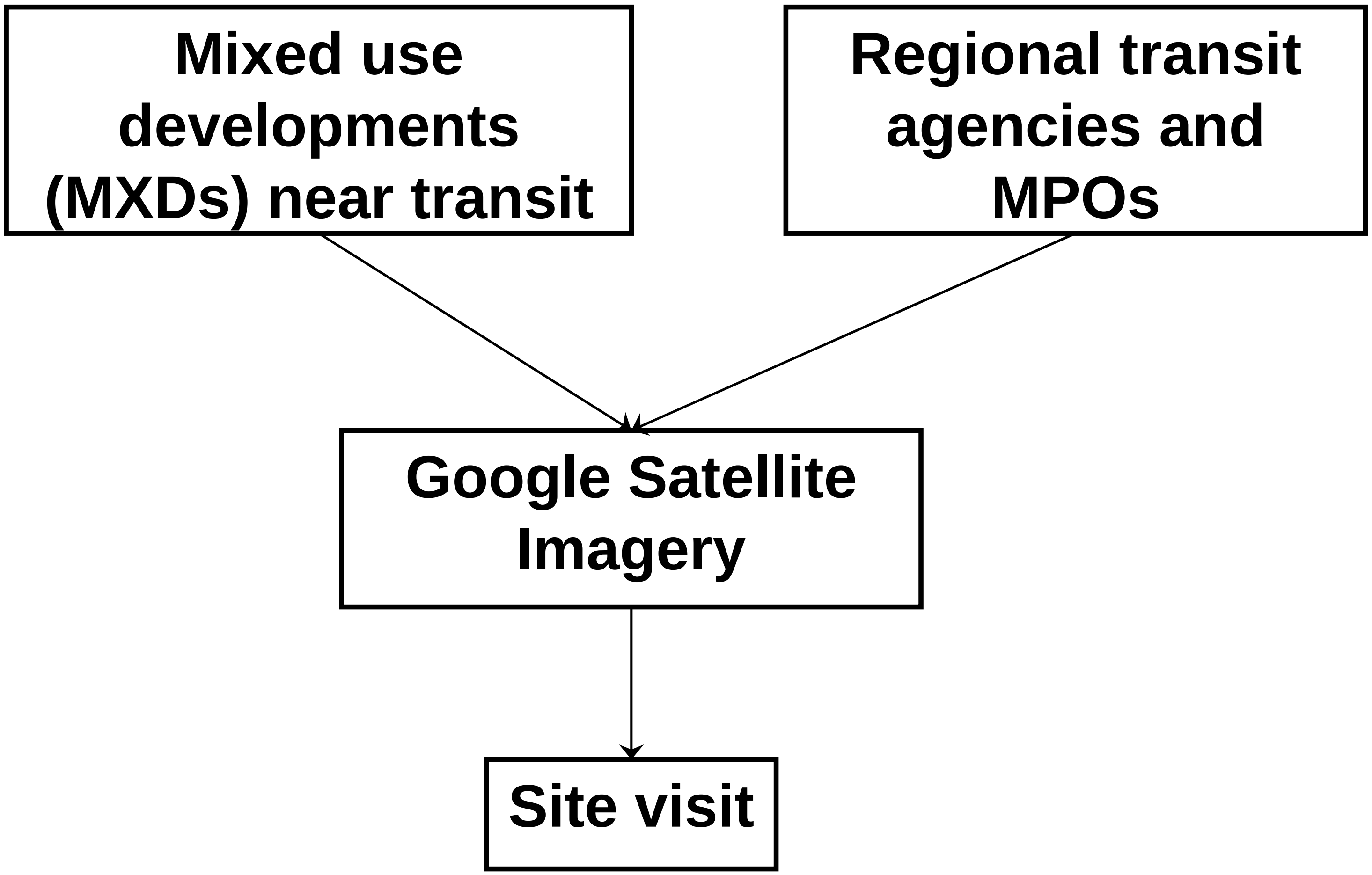
Adjacent to transit

Built after transit

Fully developed or nearly so

Self-contained parking

TOD Selection



Lindbergh City Center
Atlanta

City Creek Center
Salt Lake City

Station Landing
Boston

Redmond TOD
Seattle

Englewood Denver

City College San Diego

Del Mar
Los Angeles

Fruitvale Village
San Francisco

Orenco Station
Portland

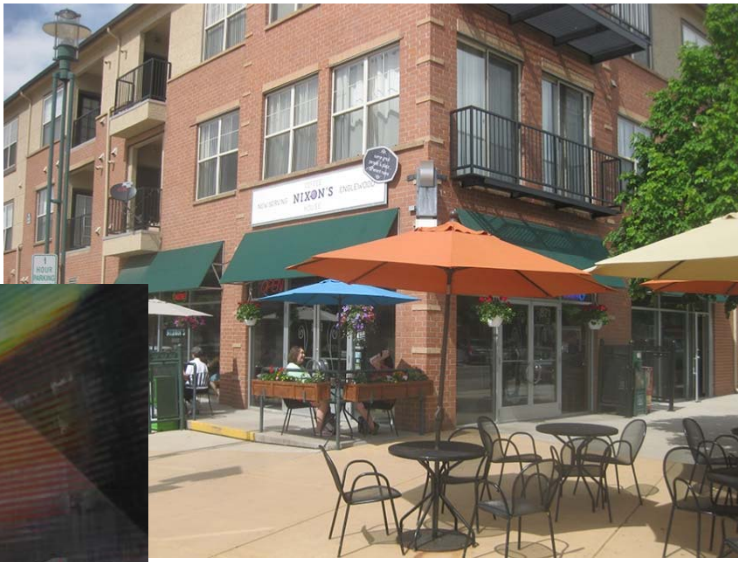
Rhode Island Row
Washington, D.C.

Redmond TOD, Seattle

Rhode Island Row, Washington D.C.

Fruitvale Village, San Francisco

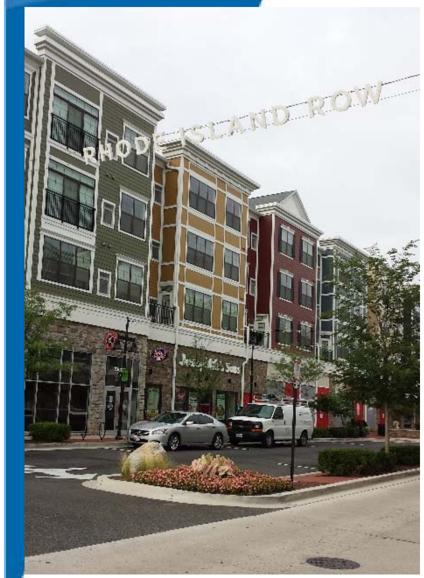
Wilshire/Vermont, Los Angeles

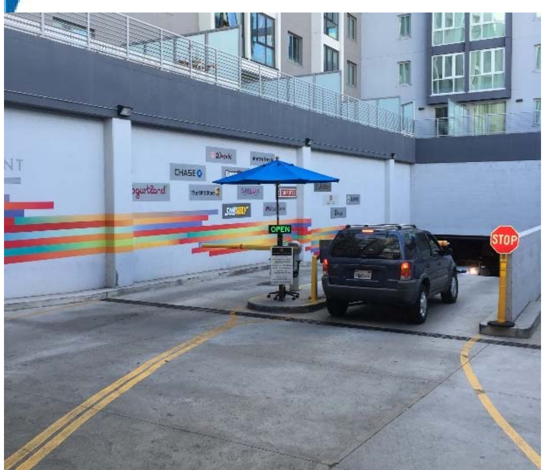


Englewood TOD, Denver

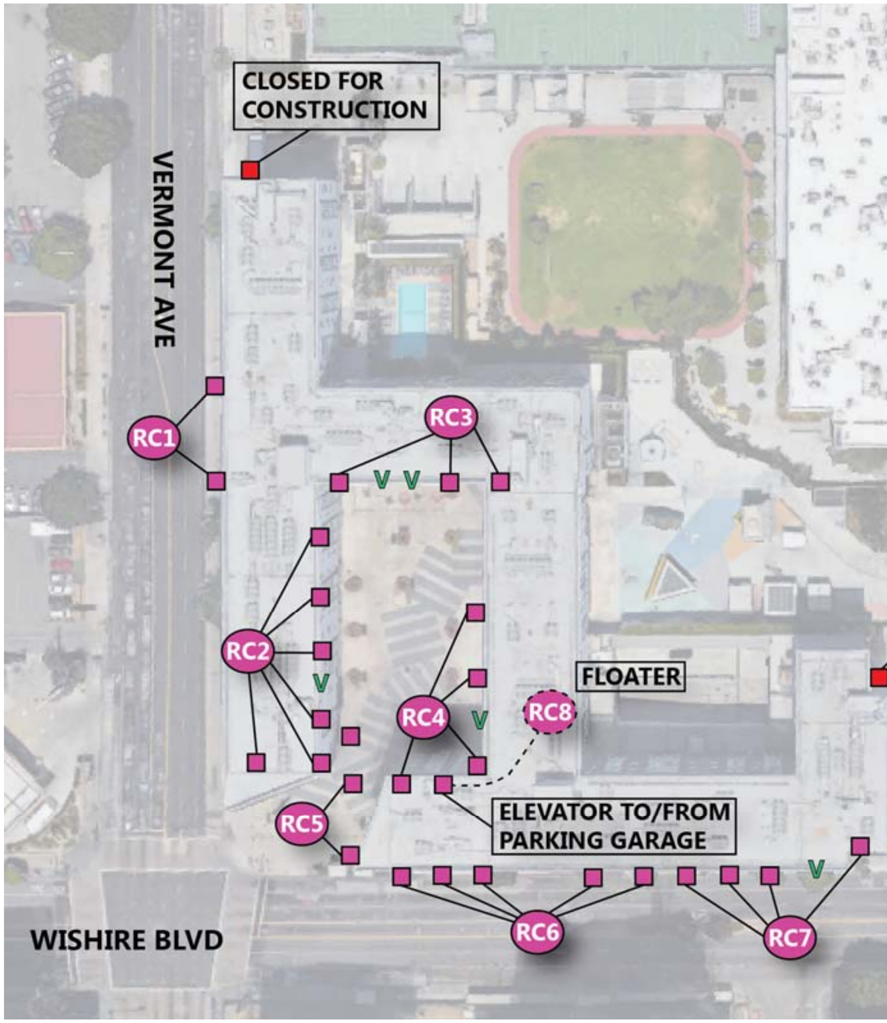
Pylon #2
Rhode Island Avenue
34,800 CPD
Pylon #1
RHODE ISLAND AVENUE/ BRENTWOOD
Parking Exit
168 PUBLIC PARKING SPACES
Garage 2
Elevator
Ramp
Service Corridor
CVS
101 N
CAROLINA Kitchen
102 N
Proposed Entry
Phenix Salon Suites
104 N
TKO Burger
102A N
2,594 SF
106 N
3,003 SF
105 N
DC DMV
112 N
1,089 SF
111 N
2,111 SF
110 N
109 N
1,793 SF
108 N
1,744 SF
107 N
NORTH BUILDING RESIDENTIAL LOBBY
Parking Entrance
Washington Place
MAIN STREET: 42 ON-STREET PARKING SPACES
2,286 SF
112 S
2,113 SF
111 S
1,059 SF
110 S
Arte Nail & Spa
109 S
T-Mobile
108 S
Sprint
107 S
Sala Thai
106 S
1,707 SF
105 S
1,479 SF
104 S
2,224 SF
103 S
Jersey Mike's Subs
102 S
Chipotle
101 S
Service Corridor
Fitness Center
Elevator
Washington Place

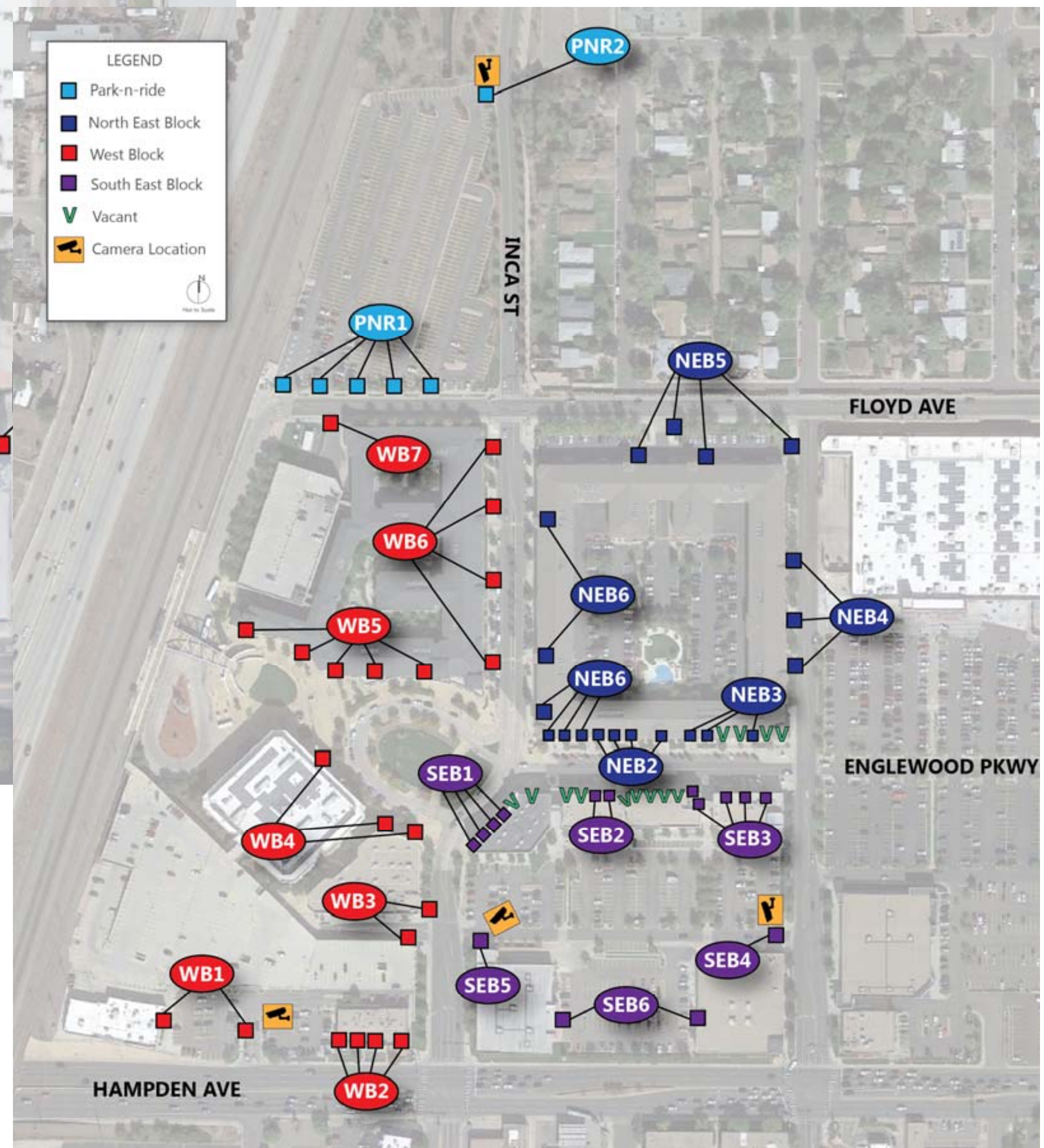
Data Collection

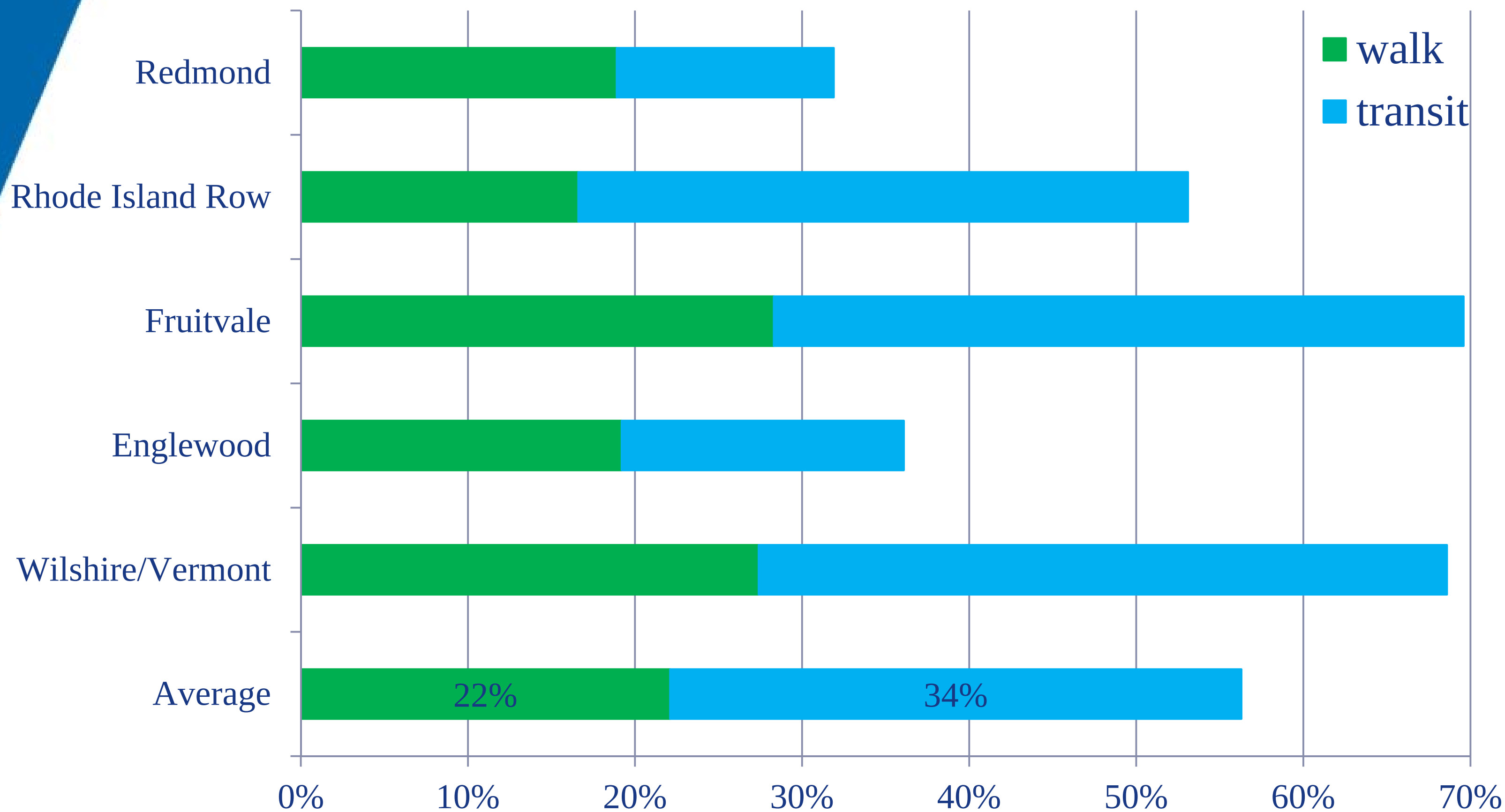




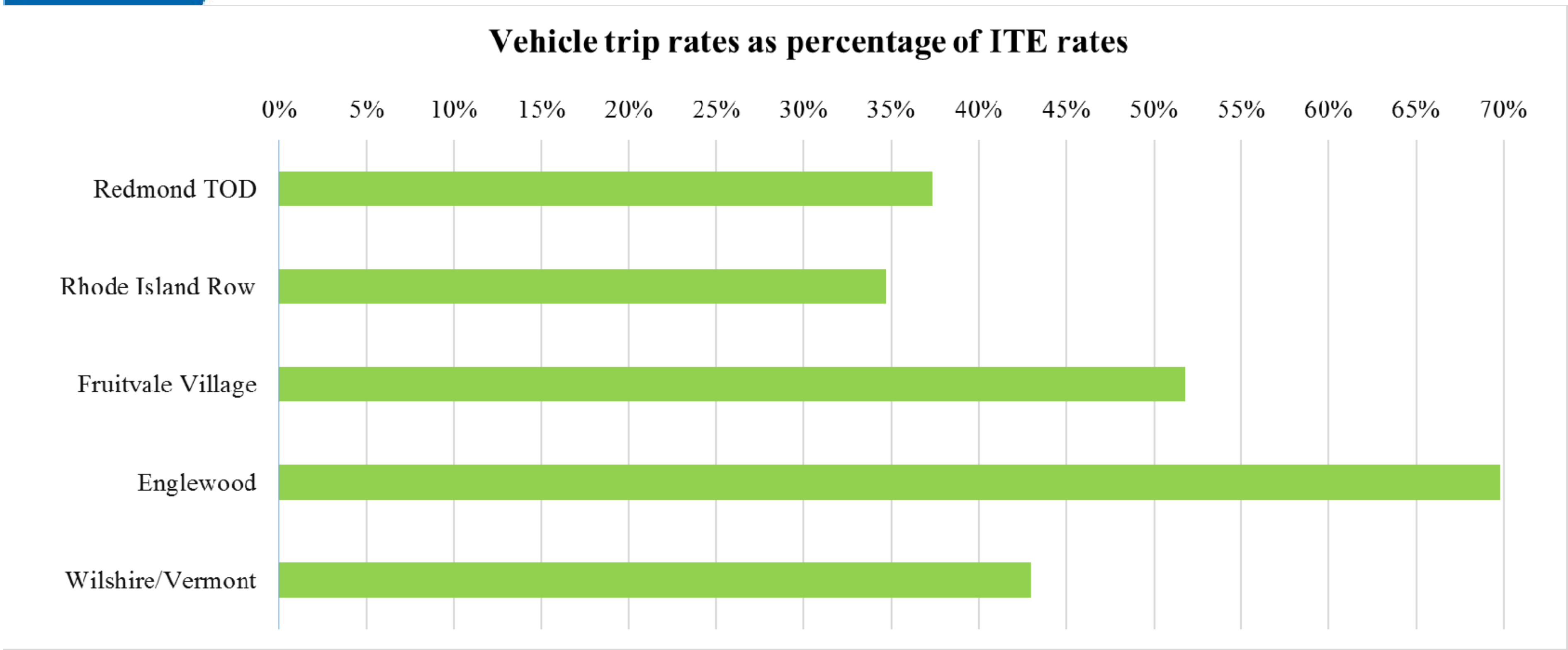
- ✓ **A count of all persons entering and exiting the buildings –** 7:30am to 9:00pm on a weekday in spring or fall 2015
- ✓ **Parking Occupancy Counts –** bi-hourly, total of 10 collections
- ✓ **A brief intercept survey of a sample of individuals entering and exiting the building**
  - "How did you get here?" (e.g., by what mode of travel?), and
  - What is the purpose of your trip?

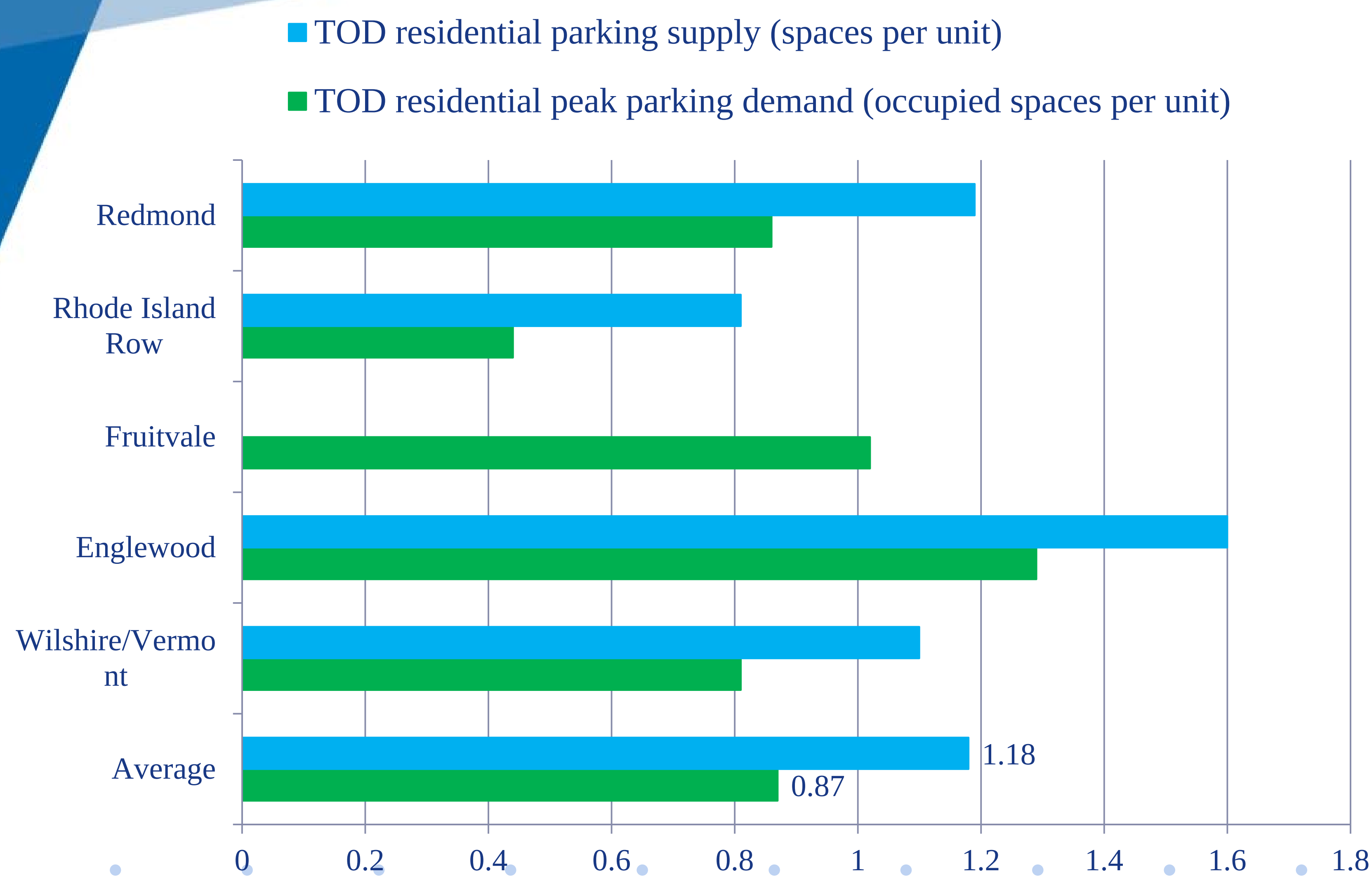

CLOSED FOR CONSTRUCTION
VERMONT AVE
RC1
RC2
RC3
RC4
RC5
RC6
RC7
RC8
FLOATER
ELEVATOR TO/FROM PARKING GARAGE
WISHIRE BLVD
V

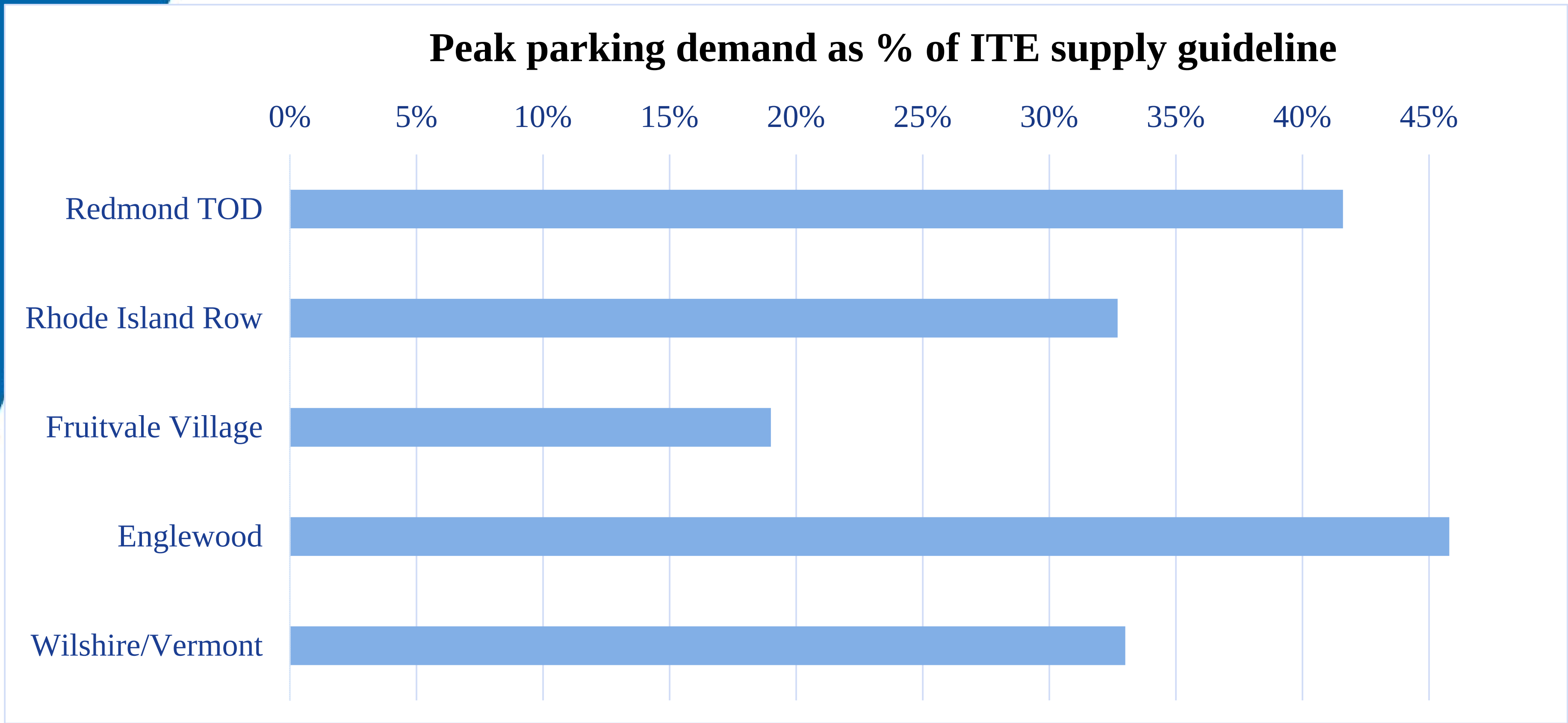

LEGEND
Park-n-ride
North East Block
West Block
South East Block
Vacant
Camera Location
PNR1
PNR2
INCA ST
FLOYD AVE
NEB2
NEB3
NEB4
NEB5
NEB6
NEB6
WB1
WB2
WB3
WB4
WB5
WB6
WB7
SEB1
SEB2
SEB3
SEB4
SEB5
SEB6
ENGLEWOOD PKWY
HAMPDEN AVE
V



Redmond
Rhode Island Row
Fruitvale
Englewood
Wilshire/Vermont
Average
22%
34%
walk
transit
0%
10%
20%
30%
40%
50%
60%
70%


Vehicle trip rates as percentage of ITE rates
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
Redmond TOD
Rhode Island Row
Fruitvale Village
Englewood
Wilshire/Vermont


TOD residential parking supply (spaces per unit)
TOD residential peak parking demand (occupied spaces per unit)
Redmond
Rhode Island Row
Fruitvale
Englewood
Wilshire/Vermont
Average
1.18
0.87
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8


Peak parking demand as % of ITE supply guideline
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
Redmond TOD
Rhode Island Row
Fruitvale Village
Englewood
Wilshire/Vermont

Parking Policies

- Lowest Parking Demand at Fruitvale Village, Rhode Island Row, and Wilshire/Vermont
  1. Shared Parking (FV, RIR)
  2. Unbundled Residential Parking (FV, RIR)
  3. Paid Commercial Parking (FV, RIR, W/V)

Structured Parking Costs

- Shoup's estimate -$22k per space back in 2005 (Don Shoup, High Cost of Free Parking, 2005)
- San Francisco study - $45k to $75k per space (Tudela-Rivadeneyra, M. S., Aldo, E. D., Shirgoakar, M., Deakin, E. A., & Riggs, W. W., The cost versus price for parking spaces at major employment centers, 2015).
- consultant's estimate - $18,599 per space (Carl Walker (2016), Mean Construction Costs, Carl Walker Consulting (www.carlwalker.com)

Cost of Parking at Redmond TOD

- $8.0 million as built
- $2.0 million unused

- $14 million if built to ITE standards
- $8 million unused

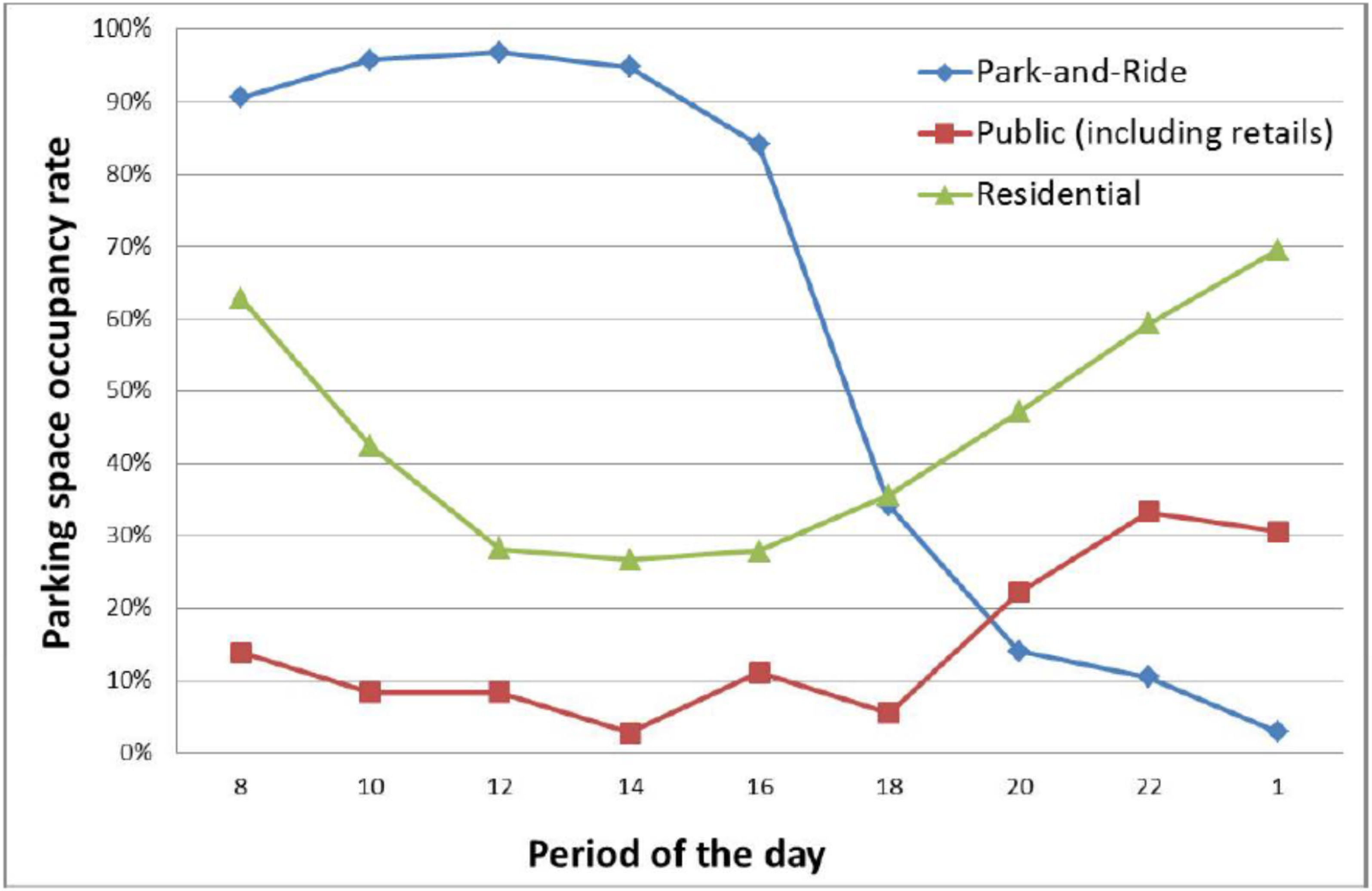


Figure 2.4. Parking Space Occupancy Rate for Different Uses at Redmond TOD

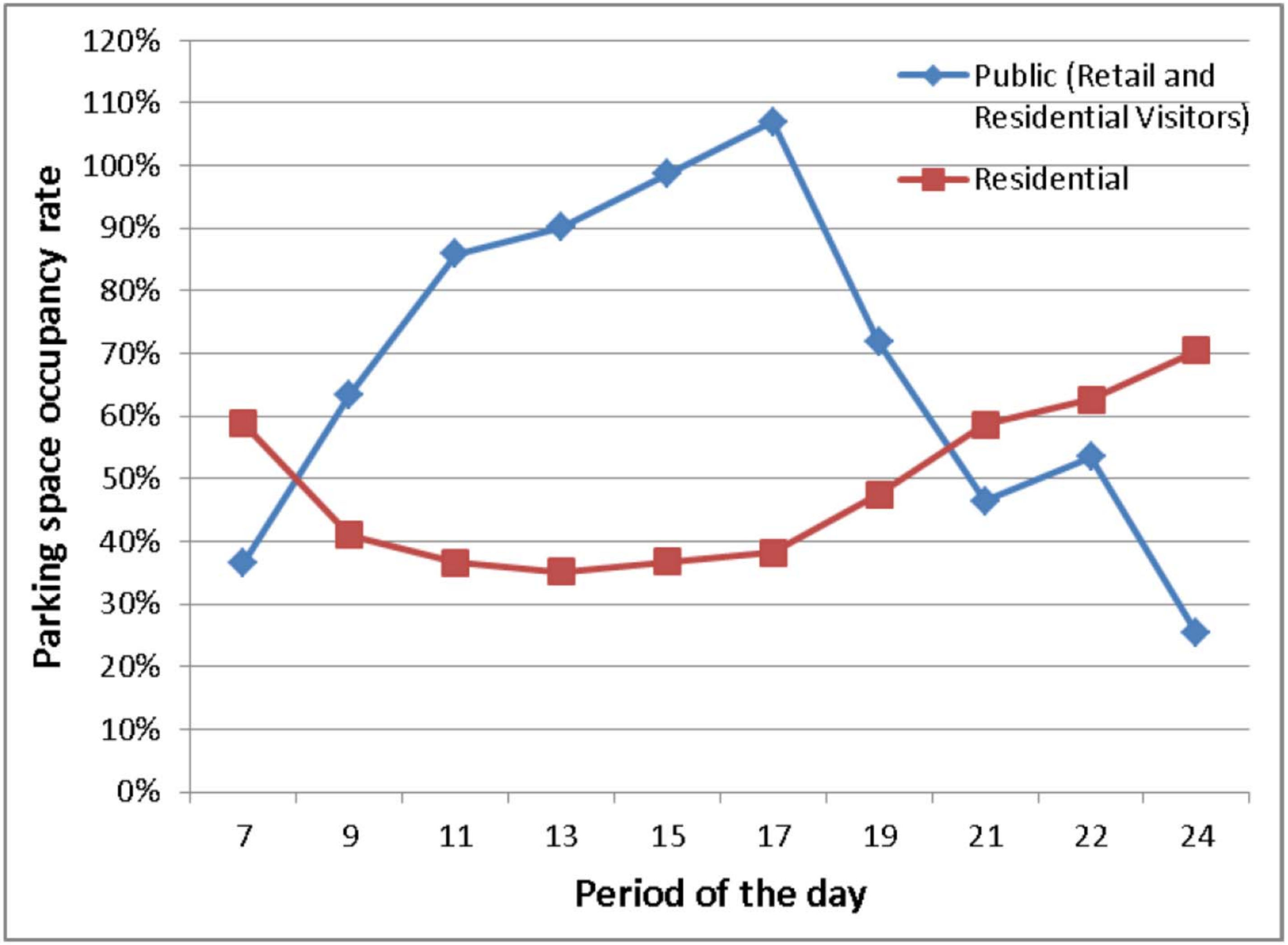


Figure 6.6. Parking Space Occupancy Rate for Different Uses at Wilshire/Vermont TOD

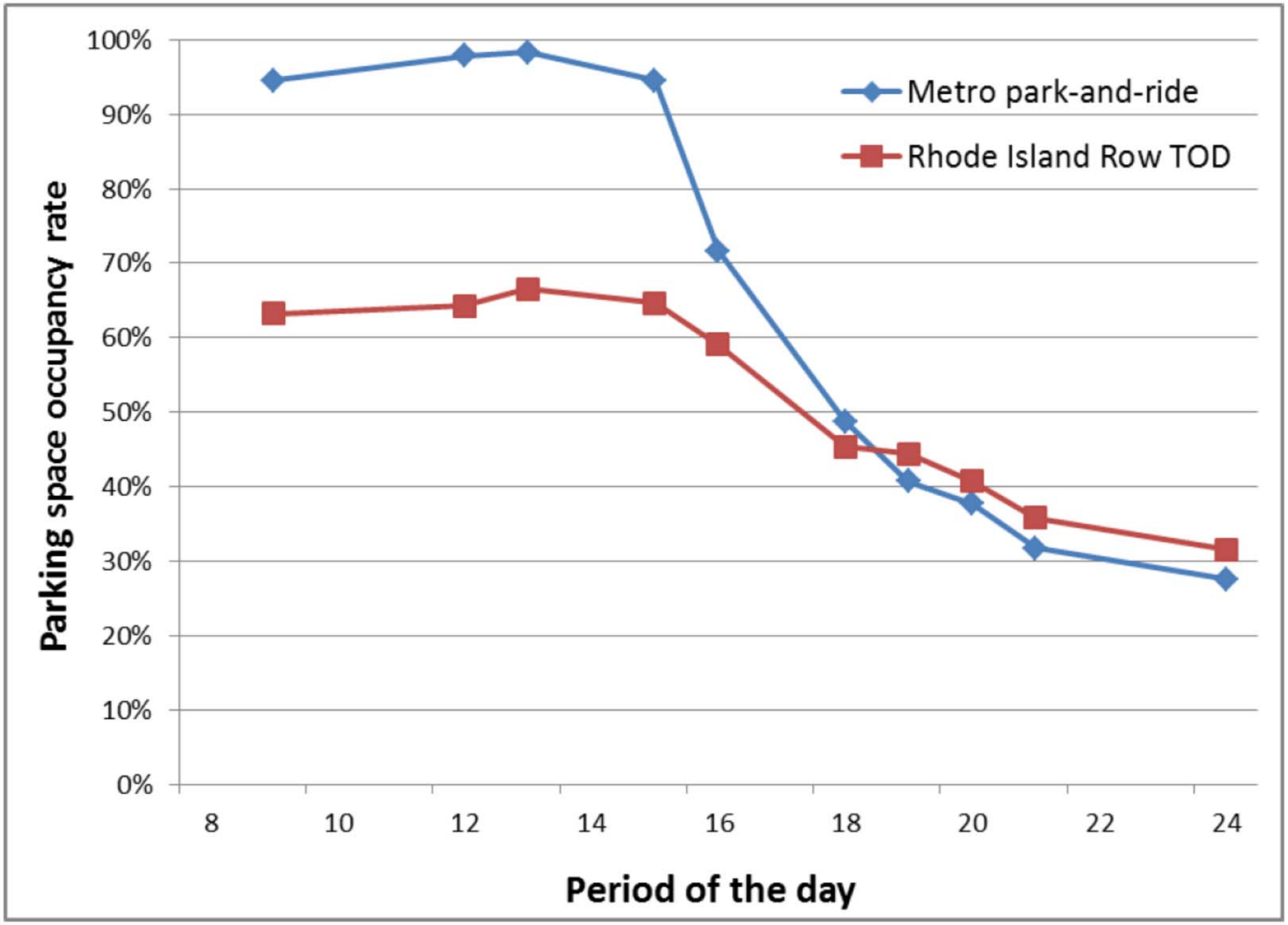
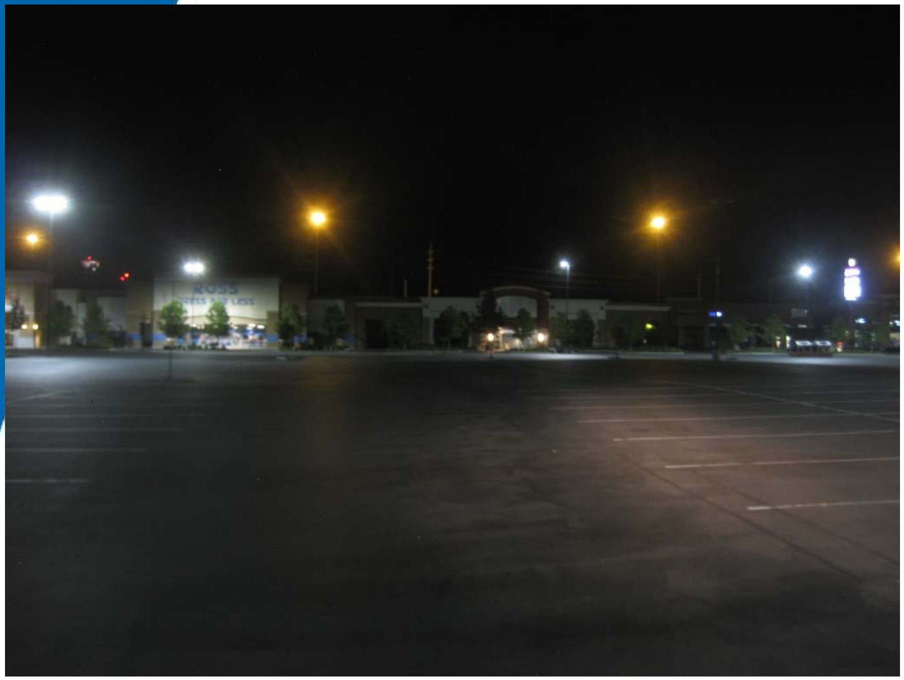


Figure 3.6. Parking Space Occupancy Rate for Different Uses at Rhode Island Row TOD

Next Case Studies



Conclusions

- With one exception, peak parking demand in these TODs was less than one half the parking supply guideline in the ITE *Parking Generation* manual.
- With one exception, vehicle trip generation rates were about half or less of what is predicted in the ITE *Trip Generation Manual*.
- Automobile mode shares were as low as one quarter of all trips, with the remainder being mostly transit and walk trips.

Trip and Parking Generation Rates for Different Housing Types: Effects of Compact Development

Presented by:

Reid Ewing, Guang Tian, and Keun Park

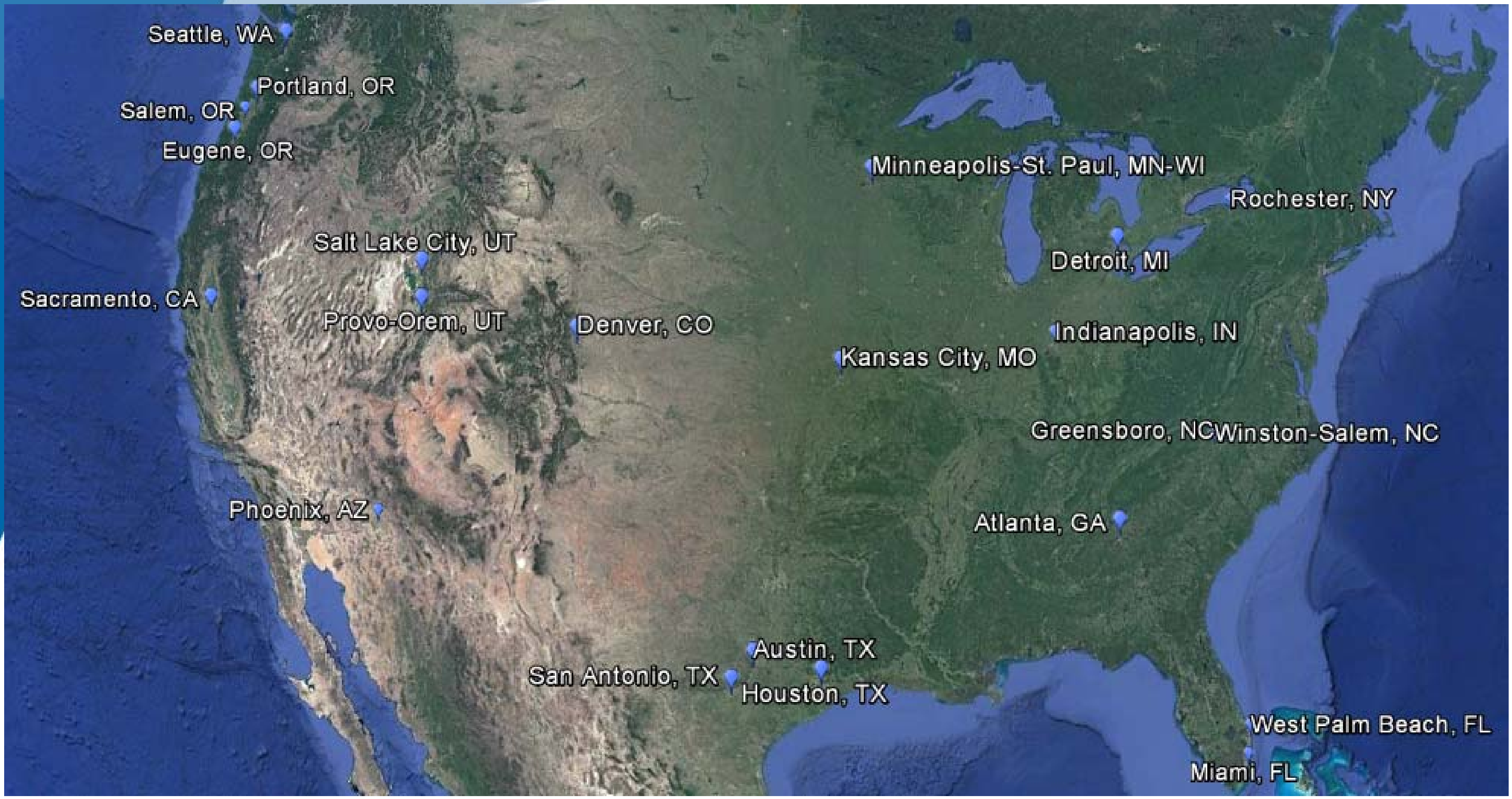
City and Metropolitan Planning
University of Utah
ewing@arch.utah.edu

In the literature

- Trip generation and degeneration
- Parking generation and car shedding

This study aims to determine how many fewer vehicle trips are generated, and how much less parking demand is generated, by different housing types (single-family attached, single-family detached, and apartment and condo) in different settings, from low density suburban environments to compact, mixed-use urban environments.

Household travel survey data



76,596 households and 766,995 trips from 21 regions.

Built environment - PCA

D variables were measured for one-mile network buffer around a household's home address.

- **sprawling neighborhoods (<= 90)**
- **average neighborhoods (90 -110)**
- **compact neighborhoods (>= 110)**

Built environment variable loadings on the neighborhood compactness index

Variable	*Factor Loadings*	*Factor Score Coefficients*
activity density	0.842	0.32
land use entropy	0.571	0.217
intersection density	0.813	0.309
transit stop density	0.83	0.316
employment accessibility	0.493	0.187

Eigenvalue: 2.629

Explained variance: 52.59%

Results

- **Descriptive statistics**
  - **Look-up tables of vehicle trips rates and vehicle ownership (parking demand) that mimic ITE's.**
- **Inferential statistics**
  - **Models of vehicle trips rates and vehicle ownership (parking demand) with respect to D variables.**

Trip Generation

21 regional database				
	Neighborhood Compactness Index	Sample Size	Vehicle trips (per unit)	Vehicle trips (per person)
Single-family Detached	1	17,196	5.05	2.09
	2	14,702	4.97	2.15
	3	9,174	4.17	2.03
	Average	41,621	4.82	2.10
Single-family Attached	1	1,252	3.64	2.19
	2	1,808	3.38	2.14
	3	2,074	2.81	1.60
	Average	5,170	3.21	1.93
Apartment and Condo	1	932	3.10	1.98
	2	2,384	2.80	1.88
	3	3,846	2.06	1.46
	Average	7,220	2.44	1.67
ITE Trip Generation Manual (weekday)				
			Vehicle trips (per unit)	Vehicle trips (per person)
Single-Family Detached (210)			9.52	2.55
Condominium/Townhouse (230)			5.81	2.49
Apartment (220)			6.65	3.31

Parking Generation

21 regional database

	Neighborhood Compactness Index	Sample Size	Vehicle Ownership (per unit)	Vehicle Ownership (per person)
Single-family Detached	1	24,278	2.34	0.96
	2	20,973	2.11	0.91
	3	12,848	1.81	0.87
	Average	58,922	2.14	0.92
Single-family Attached	1	1,561	1.64	0.91
	2	2,328	1.42	0.84
	3	2,723	1.26	0.67
	Average	6,663	1.41	0.79
Apartment and Condo	1	1,183	1.36	0.83
	2	3,129	1.17	0.76
	3	4,885	0.96	0.66
	Average	9,277	1.09	0.72

ITE Parking Generation (weekday)

	Setting	Peak Demand (vehicles per unit)
Single-Family Detached (210)	—	1.83
Townhouse/Condominium (230)	Suburban	1.38
Low/Mid-Rise Apartment (221)	Suburban	1.23
	Urban	1.20
High-Rise Apartment (222): 5 or more floors	Central City, not downtown	1.37

Trip Generation

Multilevel negative binomial regression for household vehicle trip generation			
	Single-family Detached	Single-family Attached	Apartment and Condo
intercept	1.089***	1.225***	1.098***
regional population	-0.00002***	-0.00003**	—
household size	0.167***	0.206***	0.187***
workers	0.117***	0.146***	0.209***
household income	0.002***	0.002***	0.003***
neighborhood compactness index	-0.002***	-0.006***	-0.007***
pesudo-R^2	0.33	0.28	0.22

"—" means this variable is not statistically significant.
**** p-value < 0.01, ** p-value < 0.05, * p-value < 0.1*

Parking Generation

Multilevel Poisson regression for household vehicle ownership

	Single-family Detached	Single-family Attached	Apartment and Condo
intercept	0.718***	0.312***	0.385***
regional compactness index	—	—	-0.0026***
regional population	—	—	-0.00003**
household size	0.057***	0.099***	0.107***
workers	0.148***	0.190***	0.208***
household income	0.002***	0.003***	0.005***
neighborhood compactness index	-0.005***	-0.006***	-0.005***
pesudo-R^2	0.87	0.83	0.67

"—" means this variable is not statistically significant.

*** *p-value* < 0.01, ** *p-value* < 0.05, * *p-value* < 0.1

Conclusion

- Vehicle trip generation and vehicle ownership (and hence parking demand) decrease with the compactness of neighborhood development, (after controlling for sociodemographic variables).

- The tables and models capture the phenomena of “trip degeneration” and “car shedding” as development patterns become more compact.

- This analysis is being updated to 30 regions, including Dallas.

Thank you !