PBIC Livable Communities Webinar Series

Tools for Pedestrian and Bicycle Safety and Exposure Analysis

David Ragland, Founding Director, UC Berkeley SafeTREC

John Bigham, GIS Program Manager, SafeTREC

Robert Schneider, Researcher, SafeTREC

June 5, 1 pm

Pedestrian and Bicycle Information Center

THE UNIVERSITY OF NORTH CAROLINA HIGHWAY SAFETY RESEARCH CENTER

Today’s Presentation

- **Introduction and housekeeping**
- **Audio issues?** Dial into the phone line instead of using “mic & speakers”
- **PBIC Trainings and Webinars**

  http://www.walkinginfo.org
- **Registration and Archives at**

  http://walkinginfo.org/webinars
- **Questions at the end**

Webinar

Tools for Pedestrian and Bicycle Safety and Exposure Analysis

Tuesday, June 5, from 10-11:30am (PDT)

- Introduction

- David Ragland, UC Berkeley SafeTREC
- www.tsc.berkeley.edu

Topics

- SafeTREC (Overview)
- Pedestrian and Bicyclist Safety (Examples)
- Data Reports and Data Tools (Examples)
- Data steps for pedestrian and bicyclist safety

SafeTREC

- Founded in 2000 with a grant from OTS to reduce traffic fatalities and injuries through multi-disciplinary collaboration in education, technical assistance, and outreach.

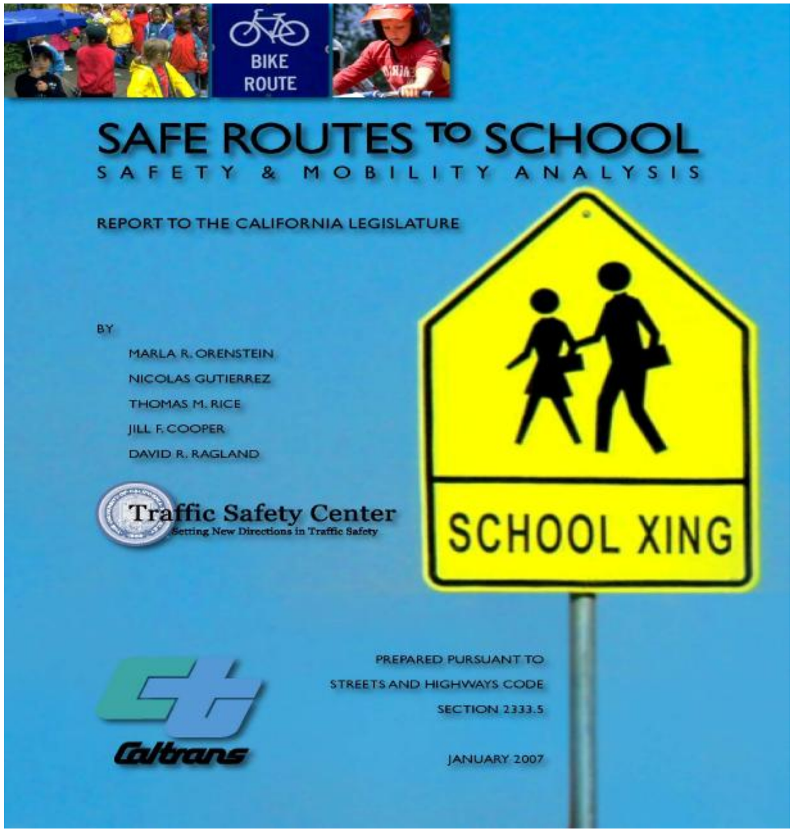
- UC Partners include Public Health, Transportation Engineering, City and Regional Planning

- Funders have included NHTSA, OTS, Caltrans, local cities, agencies, foundations

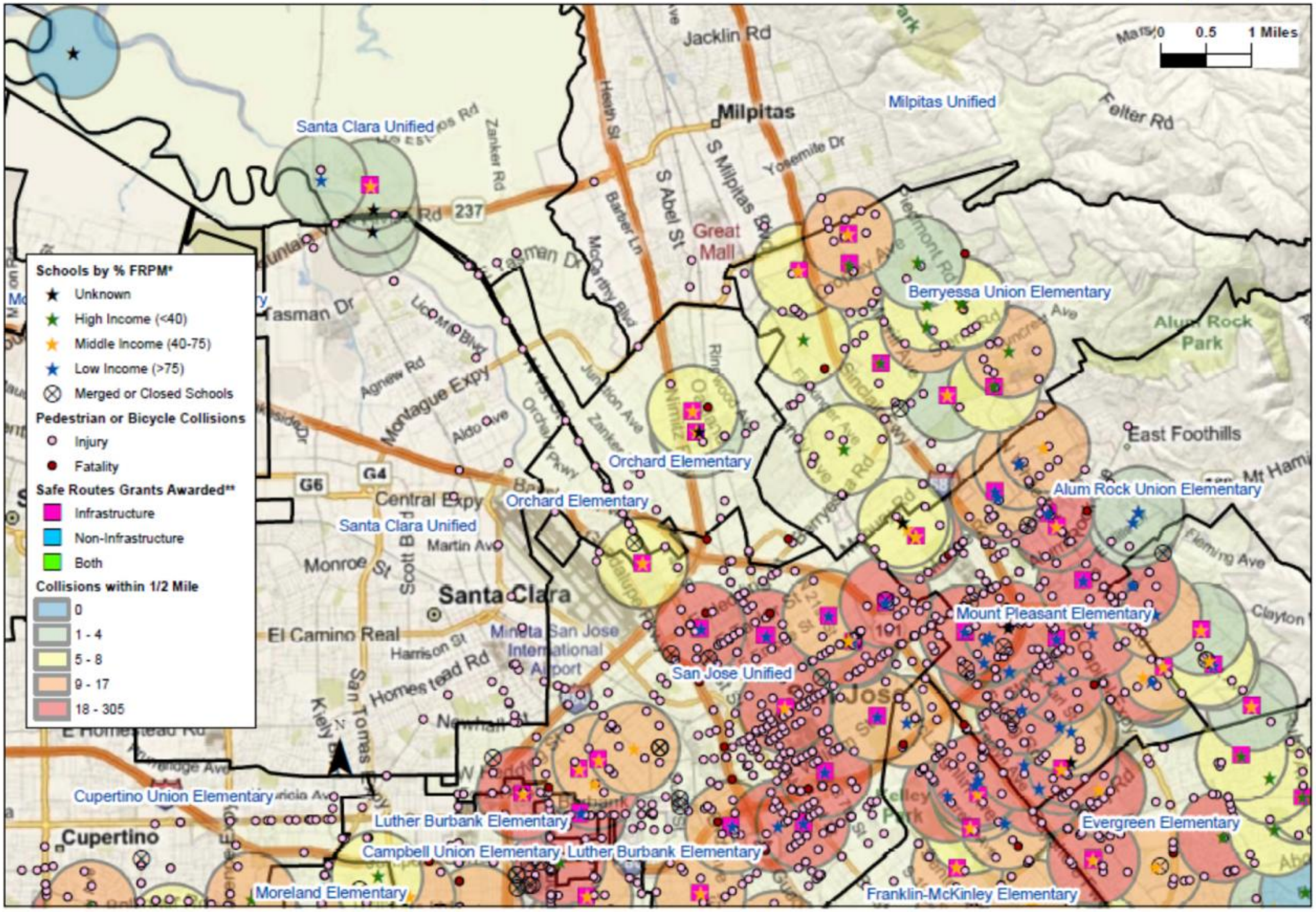
Topics

- SafeTREC (Overview)
- Pedestrian and Bicyclist Safety (Examples)
- Data Reports and Data Tools (Examples)
- Data steps for pedestrian and bicyclist safety

Safe Routes to School Safety and Mobility Analysis: Report to the California Legislature



San Jose - Pedestrian or Bicycle Collisions Near School Sites (2006-2008)

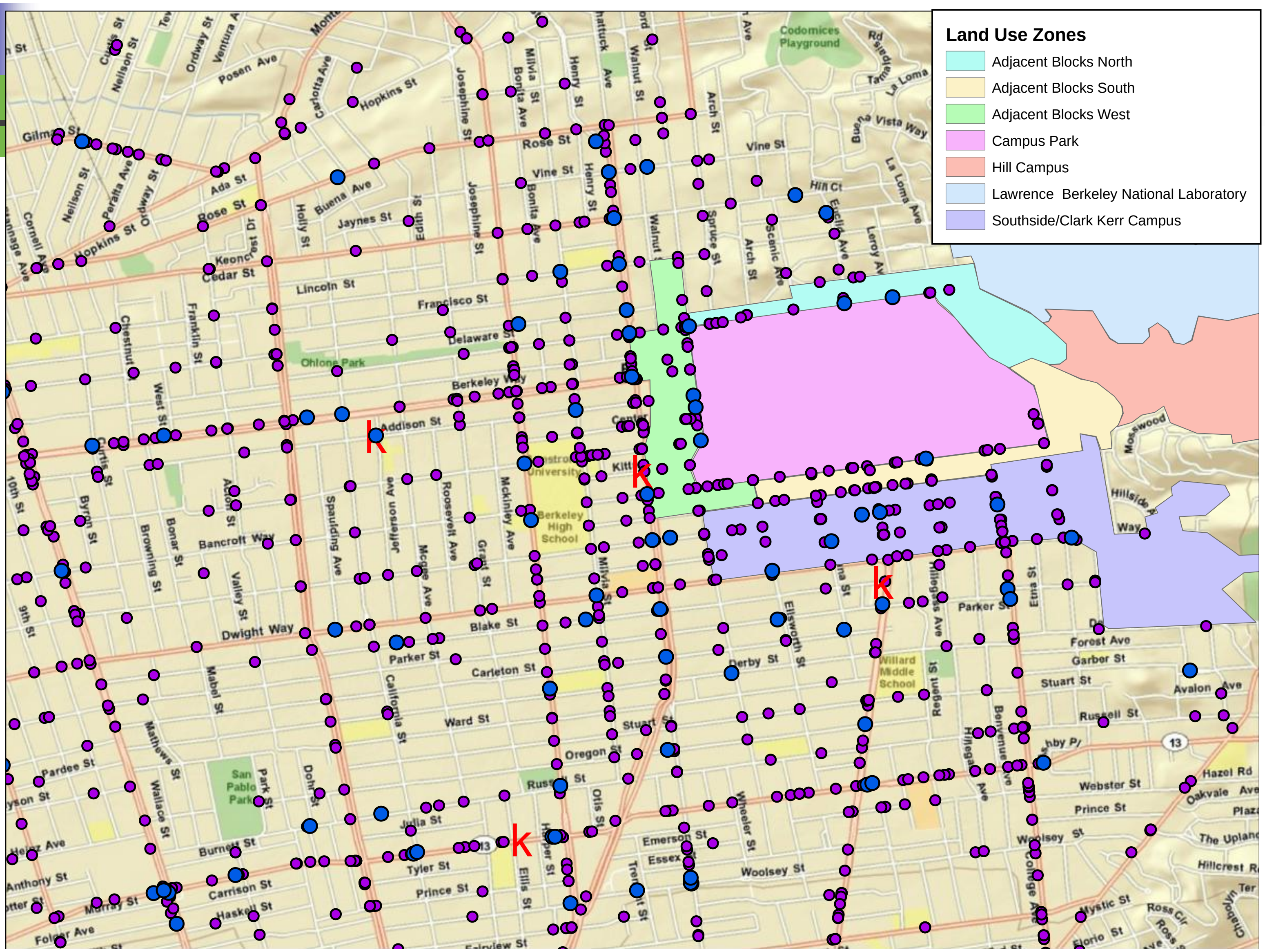


*Schools classified according to percentage of students eligible for the Free/Reduced Price Meal Program (2008).
**Safe Routes to School awards include state and federal funding from 2005 - 2010.

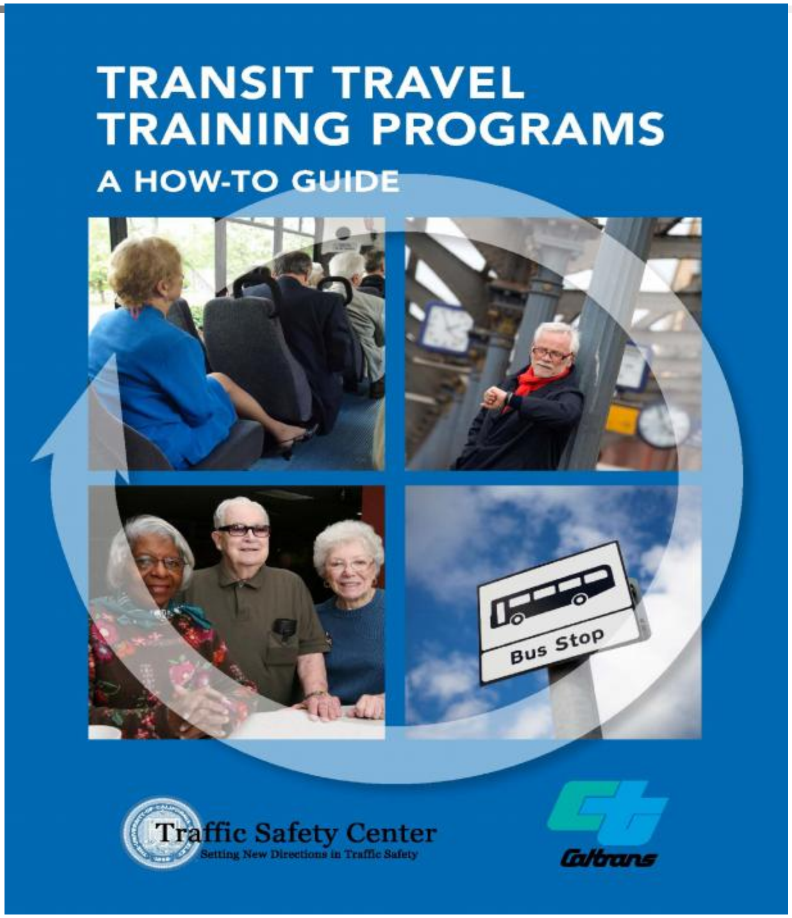
Sources: California Public School Database; SWITRS 2006-2008; Bing Maps

UC Campus Periphery Project

k Fatal ● Severe Injury ● Minor Injury



Barriers to Transit among Seniors



Topics

- SafeTREC (Overview)
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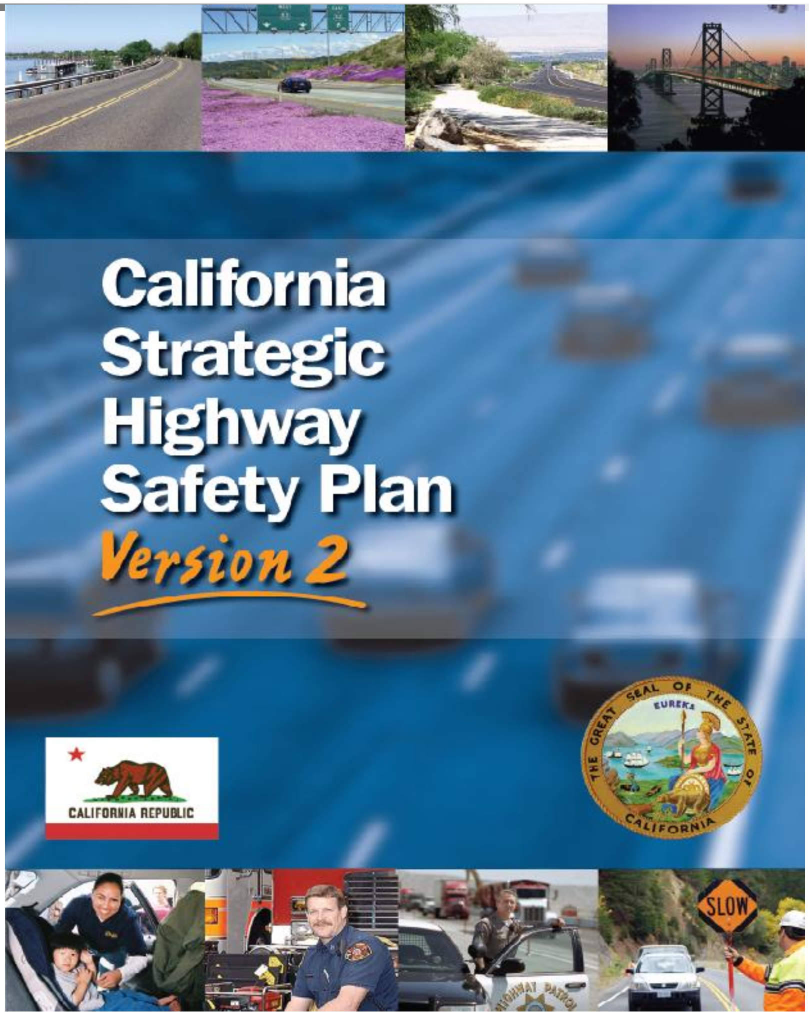
- Data steps for pedestrian and bicyclist safety

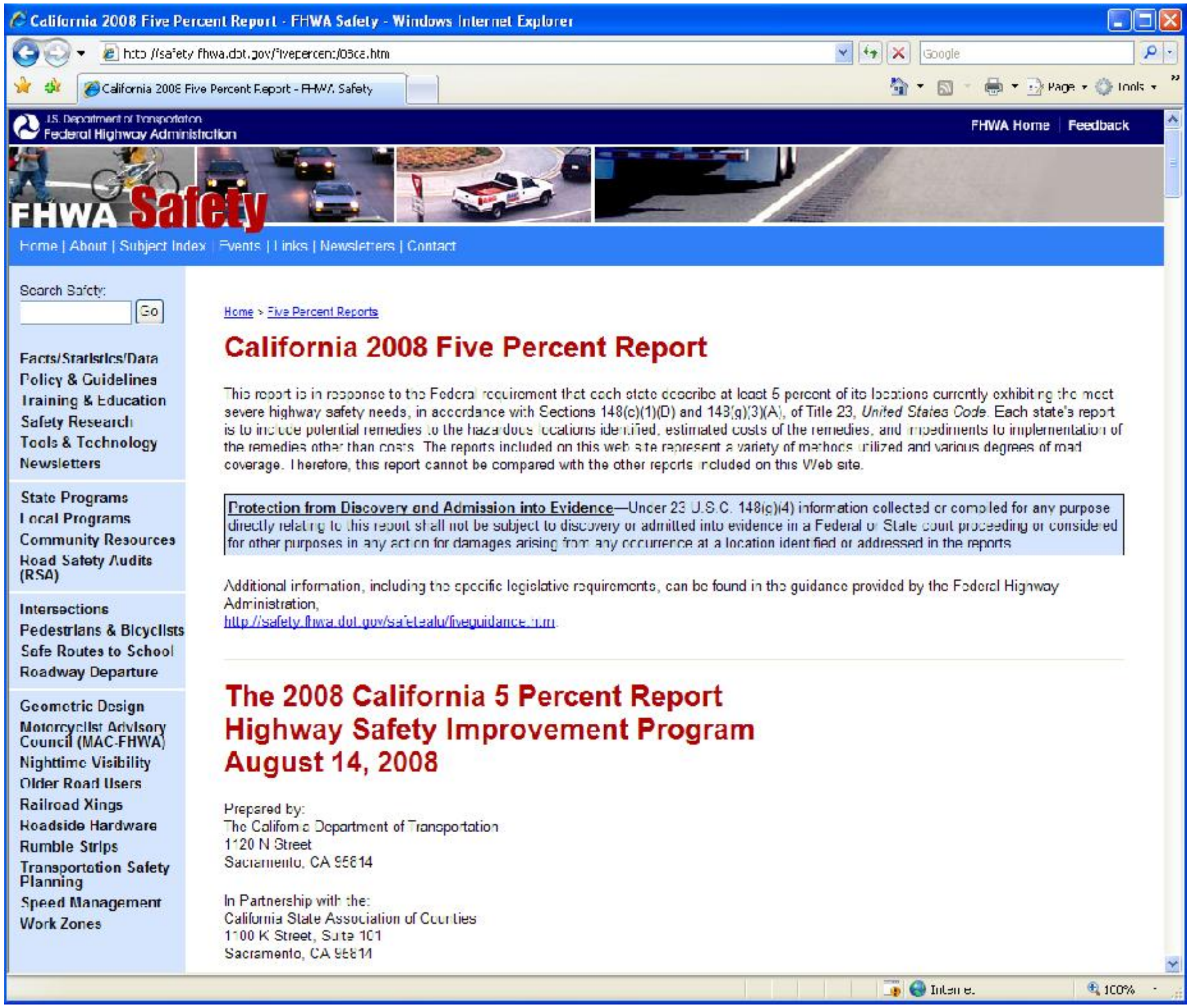
Strategic Highway Safety Plan (Data Support Contract)

- Roles
  - Data Support
    - Provide standard and customized data analyses to each Challenge Area
  - 5% Report
    - Local Roads
  - Challenge area participation

SHSP Version 2

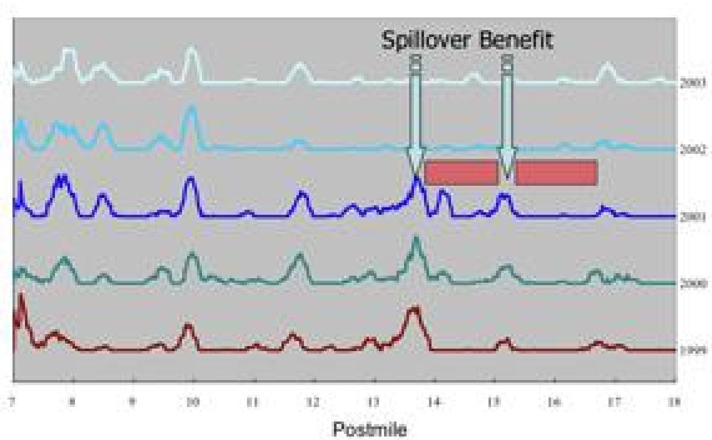


5% Report


California 2008 Five Percent Report - FHWA Safety - Windows Internet Explorer
U.S. Department of Transportation
Federal Highway Administration
FHWA Home | Feedback
FHWA Safety
Home | About | Subject Index | Events | Links | Newsletters | Contact
Search Safety:
Go
Facts/Statistics/Data
Policy & Guidelines
Training & Education
Safety Research
Tools & Technology
Newsletters
State Programs
Local Programs
Community Resources
Road Safety Audits (RSA)
Intersections
Pedestrians & Bicyclists
Safe Routes to School
Roadway Departure
Geometric Design
Motorcyclist Advisory Council (MAC-FHWA)
Nighttime Visibility
Older Road Users
Railroad Xings
Roadside Hardware
Rumble Strips
Transportation Safety Planning
Speed Management
Work Zones
Home > Five Percent Reports
California 2008 Five Percent Report
The 2008 California 5 Percent Report
Highway Safety Improvement Program
August 14, 2008
Prepared by:
In Partnership with the:
California State Association of Counties

12

Continuous Risk Profile (CRP)

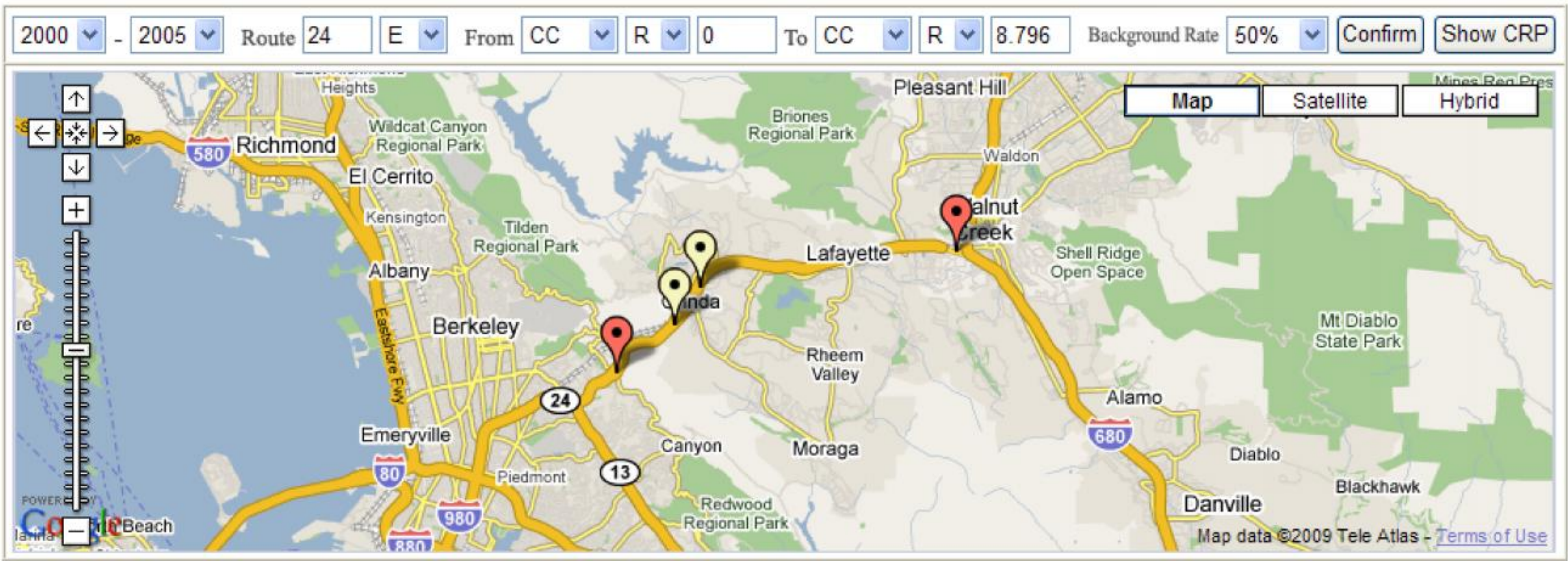


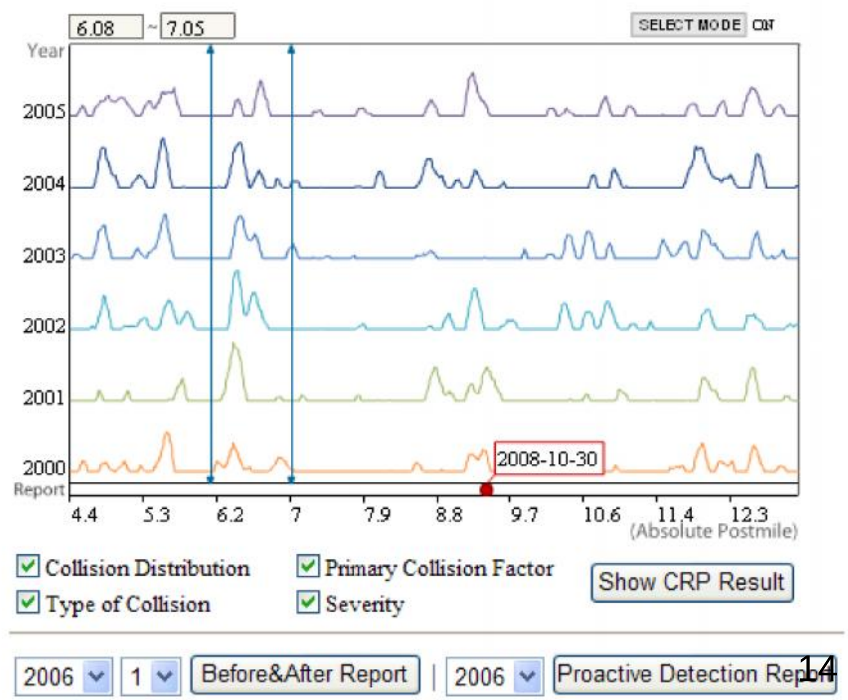
Continuous Risk Profile (CRP) Demonstration Webinar for Caltrans District Leaders

Background: Many existing methods for detecting collision concentration locations (such as the conventional sliding moving window approach) require segmentation of roadways and assume traffic collision data are spatially uncorrelated, resulting in false positives and false negatives.

CRP Capabilities:
• does not require segmentation of roadways
• spatial correlation in the collision data does not affect results
• lower false positive rates
• proactive identification of locations
• plots are highly reproducible over the years
• can capture "spillover benefit" of countermeasures
• simple to use.

Continuous Risk Profile Analysis





Topics

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- Data Reports and Data Tools (Examples)
- Data steps for pedestrian and bicyclist safety

Data steps for pedestrian and bicyclist safety

	Areas	Examples from SafeTREC	Presenter
1.	Crash/injury data	TIMS (geocoding)	John
2.	Data access	Public Access to TIMS	John
3.	Pedestrian/bicycle volume	Location-based analyses	Bob
4.	Hazard assessment	Bayesian analysis, Continuous Risk Profile	
5.	Causal analysis / countermeasure assessment	Collision modification factors	
6.	Benefit/cost	Safety Index	John
7.	Integration with larger roadway data systems	Integrate active transportation data with Caltrans data system	

UC Berkeley Home

SafeTREC Safe Transportation Research & Education Center

ITSBerkeley Institute of Transportation Studies

School of Public Health

PBIC Webinar—Tools for Pedestrian and Bicycle Safety and Exposure Analysis

John Bigham
jbigham@berkeley.edu

Safe Transportation Research and Education Center
University of California, Berkeley
www.safetrec.berkeley.edu

Topics

- Overview of TIMS
- Accessing and visualizing pedestrian and bicycle collision data in TIMS
  - SWITRS Query & Map
  - SWITRS GIS Map
- Benefit-cost calculator for safety countermeasures

Transportation Injury Mapping System (TIMS)

- Provides data and mapping analysis tools and information for traffic safety related research, policy and planning.
- Free account application, open to everyone
- http://tims.berkeley.edu

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SWITRS

- California Statewide Integrated Traffic Records System
- Maintained by California Highway Patrol
- Approximately 200,000 injury collisions each year

SWITRS Query & Map Tool

- Data query focused application
  - Quick results, quick refresh
- One page summary statistics
- Download collision, party, victim files
- Google Maps collision display
  - 5,000 collisions limit
  - Collision points clustered until zoomed in

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SWITRS GIS Map

- Map-centric collision viewing with other data layers (census tracts, TAZ, schools, etc.)
- Same collision query UI as Query & Map tool
- 1,000 collisions display limit
- Focused collision spatial selection tools
  - Drawing
  - Buffer (intersection or corridor)
  - Region (TAZ, census tract, zip code)

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TIMS Mapping Applications

- DEMO

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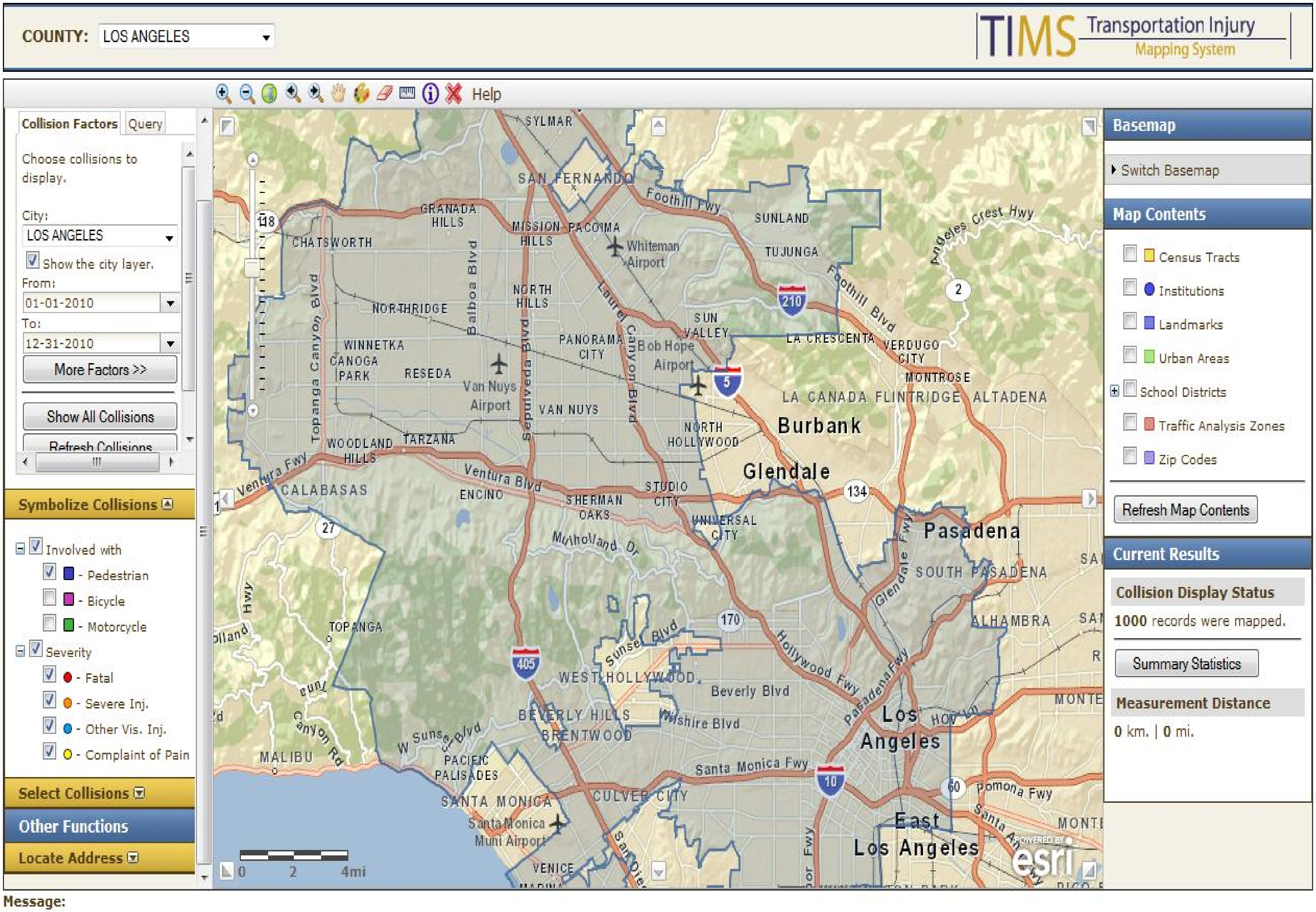
COUNTY: LOS ANGELES
TIMS Transportation Injury Mapping System
Help
Collision Factors
Query
Choose collisions to display.
City:
LOS ANGELES
Show the city layer.
From:
01-01-2010
To:
12-31-2010
More Factors >>
Show All Collisions
Refresh Collisions
Symbolize Collisions
Involved with
- Pedestrian
- Bicycle
- Motorcycle
Severity
- Fatal
- Severe Inj.
- Other Vis. Inj.
- Complaint of Pain
Select Collisions
Other Functions
Locate Address
Basemap
Switch Basemap
Map Contents
Census Tracts
Institutions
Landmarks
Urban Areas
School Districts
Traffic Analysis Zones
Zip Codes
Refresh Map Contents
Current Results
Collision Display Status
1000 records were mapped.
Summary Statistics
Measurement Distance
0 km. | 0 mi.
SYLMAR
SAN FERNANDO
Foothill Fwy
SUNLAND
TUJUNGA
GRANADA HILLS
CHATSWORTH
MISSION HILLS
PACOIMA
Whiteman Airport
NORTHRIDGE
NORTH HILLS
SUN VALLEY
LA CRESCENTA
VERDUGO CITY
MONTROSE
WINNETKA
CANOGA PARK
RESEDA
Van Nuys Airport
PANORAMA CITY
Bob Hope Airport
VAN NUYS
LA CANADA FLINTRIDGE
ALTADENA
Burbank
NORTH HOLLYWOOD
WOODLAND HILLS
TARZANA
Glendale
CALABASAS
Ventura Blvd
ENCINO
SHERMAN OAKS
STUDIO CITY
UNIVERSAL CITY
Pasadena
SOUTH PASADENA
ALHAMBRA
TOPANGA
WEST HOLLYWOOD
Beverly Blvd
BEVERLY HILLS
BRENTWOOD
Wilshire Blvd
Los Angeles
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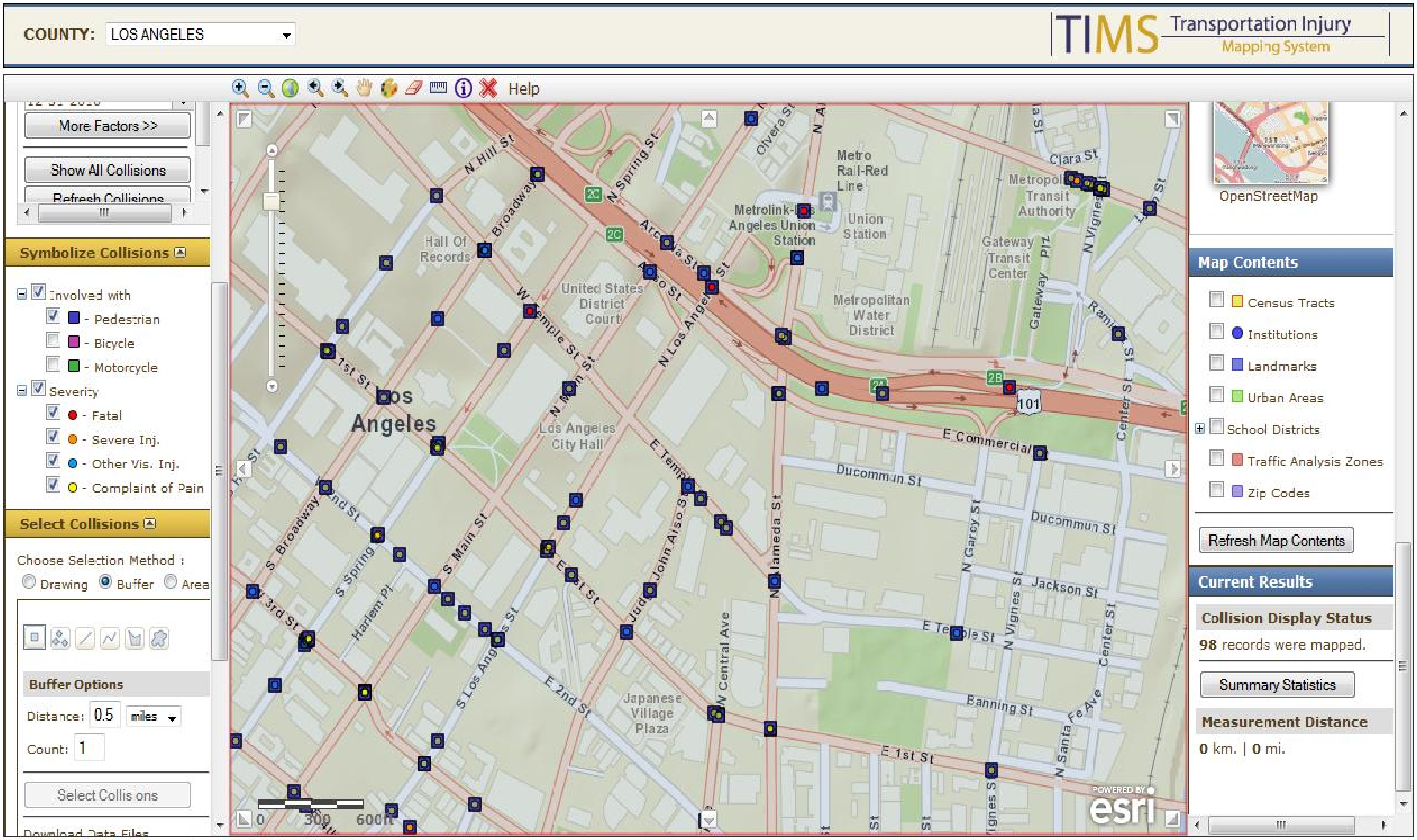


Message: Buffer Process Prepared. Select drawing option and draw on map.

Benefit-Cost Calculator

- Evaluate benefit-cost of potential safety countermeasures
  - Benefit = reduction in comprehensive collision costs
  - Cost = construction costs
- Required for agencies to use that are applying for Highway Safety Improvement Program (HSIP) funds in California
- Includes pedestrian and bicycle specific countermeasures

SafeTREC

Benefit-Cost Calculator

- DEMO

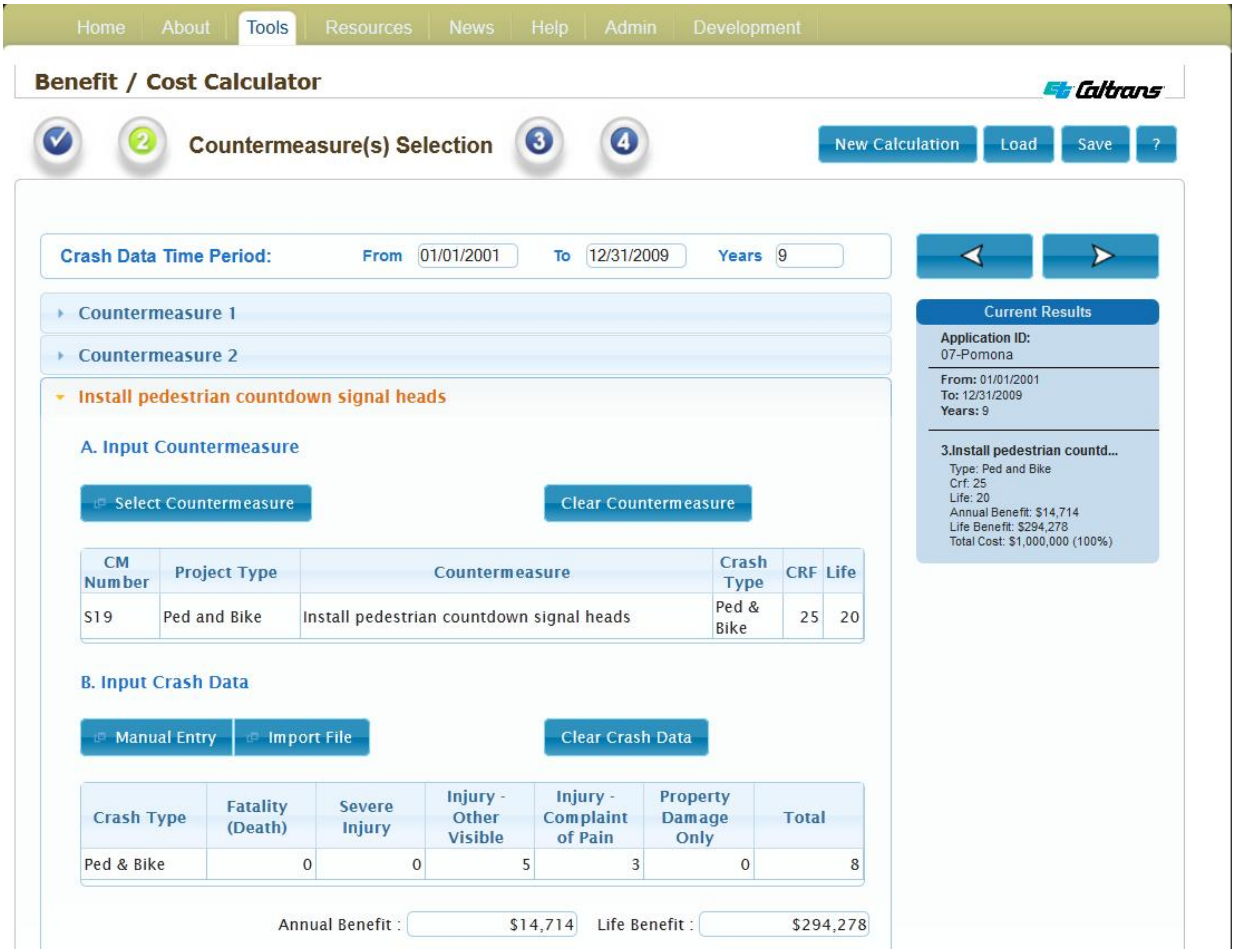
SafeTREC

Local Roadway Safety Manual

- Partnership of Caltrans, FHWA and SafeTREC
- Great resource for conceptual guidance
  - Identifying safety issues
  - Safety data analysis
  - Countermeasures selection and b/c analysis
- http://www.dot.ca.gov/hq/LocalPrograms/HSIP/apply_now.htm

SafeTREC

Import into Benefit-Cost Calculator



Select Countermeasure

Signalized | NonSignalized | Roadway

CM Number	Project Type	Countermeasure	Crash Type	CRF	Life
R29	Operation / Warning	Install curve advance warning signs (flashing beacon)	All	30	10
R30	Operation / Warning	Install dynamic / variable speed warning signs	All	30	10
R31	Operation / Warning	Install delineators, reflectors and/or object markers	All	15	10
R32	Operation / Warning	Install edge-lines and centerlines	All	25	10
R33	Operation / Warning	Install no-passing line	All	45	10
R34	Operation / Warning	Install centerline rumble strips / stripes	All	20	10
R35	Operation / Warning	Install edgeline rumble strips / stripes	All	15	10
R36	Ped and Bike	Install bike lanes	Ped & Bike	35	20
R37	Ped and Bike	Install sidewalk / pathway (to avoid walking along roadway)	Ped & Bike	80	20
R38	Ped and Bike	Install pedestrian crossing (with enhanced safety features)	Ped & Bike	30	10
R39	Ped and Bike	Install raised pedestrian crossing	Ped & Bike	35	10
R40	Animal	Install animal fencing	Animal	80	20
R41	Truck	Install truck escape ramp	All	20	20

Selected Countermeasure

CM Number	Project Type	Countermeasure	Crash Type	CRF	Life
R37	Ped and Bike	Install sidewalk / pathway (to avoid walking along roadway)	Ped & Bike	80	20

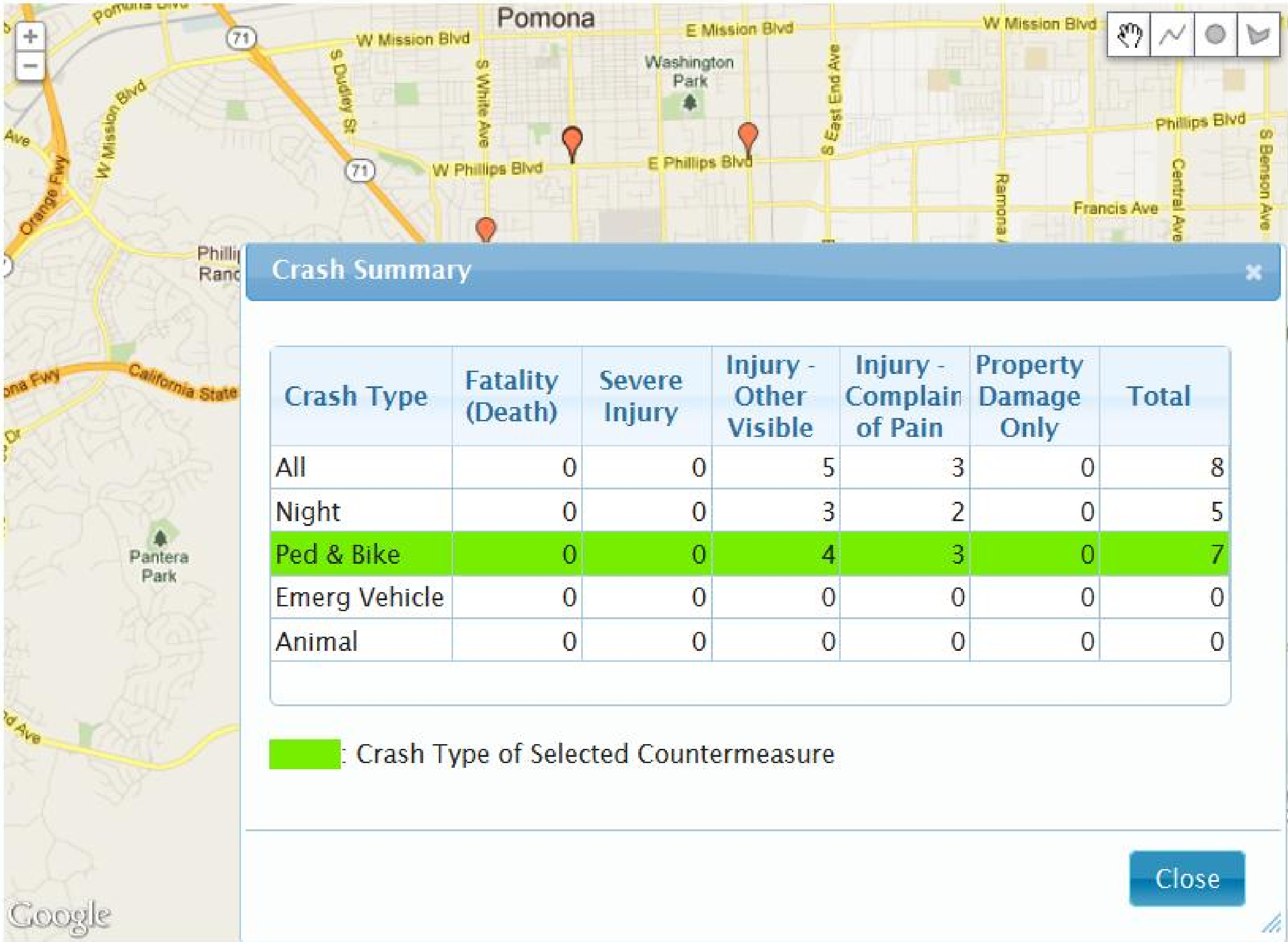
Yes Cancel

Import Crash Data file

This map will not be saved within the project. Please print the map after displaying the crash locations.

Choose File | ?

7 of 7 (100%) crash(es) mapped. (Crash Type: Ped & Bike)



Crash Summary

Crash Type	Fatality (Death)	Severe Injury	Injury - Other Visible	Injury - Complain of Pain	Property Damage Only	Total
All	0	0	5	3	0	8
Night	0	0	3	2	0	5
Ped & Bike	0	0	4	3	0	7
Emerg Vehicle	0	0	0	0	0	0
Animal	0	0	0	0	0	0

: Crash Type of Selected Countermeasure

Close

Project Information

Application ID: 07-Pomona

Crash Data: 9 years

From 01/01/2001

To 12/31/2009

Countermeasure 3

CM Number: S19

Mod: Ped and Bike

Name: Install pedestrian countdown signal heads

Crash Type: **Ped & Bike**

CRF: 25

Life: 20

Fatality - from File

Other - from File

Fatality - User Input

Other - User Input

Crash Summary

Print Map

Ok | Cancel

Home | About | Tools | Resources | News | Help | Admin | Development

Benefit / Cost Calculator

Caltrans

Result Summary

Print Summary | New Calculation | Load | Save | ?

1. Project Information

Application ID	07-Pomona	Version	2

2. Countermeasures and Crash Data

- **Install pedestrian countdown signal heads**

CM Number	Project Type	Crash Type	CRF	Life
S19	Ped and Bike	Ped & Bike	25	20

Crash Type	Fatality (Death)	Severe Injury	Injury - Other Visible	Injury - Complaint of Pain	Property Damage Only	Total
Ped & Bike	0	0	5	3	0	8

Annual Benefit	$14,714
Life Benefit	$294,278
Cost	$ 1,000,000
B/C Ratio	**0.29**

3. Benefit Cost Result

Total Benefit	$294,278
Total Cost	$1,000,000
B/C Ratio	**0.29**

Save as a Final Version | Print Summary

Funding Support

- Funding for TIMS was provided by a grant from the California Office of Traffic Safety, through the National Highway Traffic Safety Administration.
- Funding for the B/C Calculator provided by the Caltrans Division of Local Assistance

SafeTREC

Questions?

- Thank you!

SafeTREC

Pedestrian & Bicycle Volume Modeling for Crash Risk Analysis

Robert Schneider, Ph.D.
UC Berkeley Safe Transportation Research & Education Center

PBIC Webinar—June 2012

How Many People are Walking & Bicycling?

Where are People Walking & Bicycling?

What Types of Locations have the Greatest Risk of Pedestrian or Bicycle Crashes?

Pedestrian Crash Analysis

Mainline Roadway	Intersecting Roadway				Reported Pedestrian Crashes (1996-2005)	
Mission Boulevard	Torrano Avenue				5	
Davis Street	Pierce Avenue				4	
Foothill Boulevard	D Street				1	
Mission Boulevard	Jefferson Street				5	
University Avenue	Bonar Street				7	
International Boulevard	107th Avenue				2	
San Pablo Avenue	Harrison Street				2	
East 14th Street	Hasperian Boulevard				1	
International Boulevard	46th Avenue				3	
Solano Avenue	Masonic Avenue				2	
Broadway	12th Street				5	

Pedestrian RISK Analysis

Mainline Roadway	Intersecting Roadway	Estimated Total Weekly Pedestrian Crossings	Annual Pedestrian Volume Estimate	Ten-Year Pedestrian Volume Estimate	Reported Pedestrian Crashes (1996-2005)	Pedestrian Risk (Crashes per 10,000,000 crossings)
Mission Boulevard	Torrano Avenue	1,169	60,796	607,964	5	82.24
Davis Street	Pierce Avenue	1,570	81,619	816,187	4	49.01
Foothill Boulevard	D Street	632	32,862	328,624	1	30.43
Mission Boulevard	Jefferson Street	5,236	272,246	2,722,464	5	18.37
University Avenue	Bonar Street	11,175	581,113	5,811,127	7	12.05
International Boulevard	107th Avenue	3,985	207,243	2,072,429	2	9.65
San Pablo Avenue	Harrison Street	4,930	256,357	2,563,572	2	7.80
East 14th Street	Hasperian Boulevard	3,777	196,410	1,964,102	1	5.09
International Boulevard	46th Avenue	12,303	639,752	6,397,522	3	4.69
Solano Avenue	Masonic Avenue	22,203	1,154,559	11,545,589	2	1.73
Broadway	12th Street	112,896	5,870,590	58,705,898	5	0.85

Which Intersection Features are Associated with Pedestrian Risk?

(Exploratory Research)

Pedestrian Crossings (+)

While intersections with more pedestrian crossings have more pedestrian crashes, there may be a "safety in numbers" effect (i.e., lower crash risk per crossing).

(Expected Effect: 100% more pedestrian crossings, 49% more crashes)*

Motor Vehicle Volume (+)

There may be a "danger in numbers" effect with mainline motor vehicle volume, but need to explore the influence of congestion and speed.

(Expected Effect: 100% more mainline AADT, >100% more crashes)*

For more information on this study, see:

Schneider, R.J., M.C. Diogenes, L.S. Arnold, V. Attaset, J. Griswold, and D.R. Ragland. "Association between Roadway Intersection Characteristics and Pedestrian Crash Risk in Alameda County, California," Transportation Research Record: Journal of the Transportation Research Board, Volume 2198, pp. 41-51, 2010.

Which Intersection Features are Associated with Pedestrian Risk?

Number of Right-Turn-Only Lanes (+)

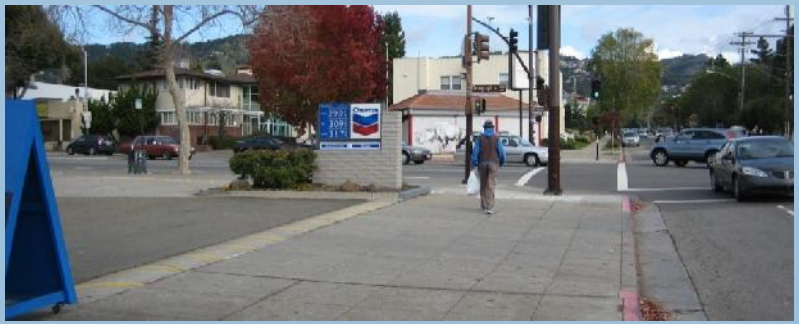
Intersections with more right-turn-only lanes may have longer crossing distances and more complex interactions between drivers and pedestrians.

(Expected Effect: 1 more right-turn-only lane, 53% more crashes)*

Number of Driveway Crossings (+)

Intersections with more non-residential driveway crossings within 50 ft. may have more conflict points; drivers may focus on entering or exiting motor vehicle lanes.

(Expected Effect: 1 more driveway crossing, 33% more crashes)*



Medians (-)

Mainline and cross-street legs with medians have a refuge that allows pedestrians to cross one direction of traffic at a time, which may make crossing safer.

(Expected Effect: Medians on mainline roadway crossings, 75% fewer crashes)*

Which Intersection Features are Associated with Pedestrian Risk?

Number of Commercial Properties (+)
Intersections with more commercial properties within 0.1 miles may have more drivers looking at signs and for parking; more pedestrians may cross between cars.

(Expected Effect: 10 more commercial properties: 45% more crashes)*

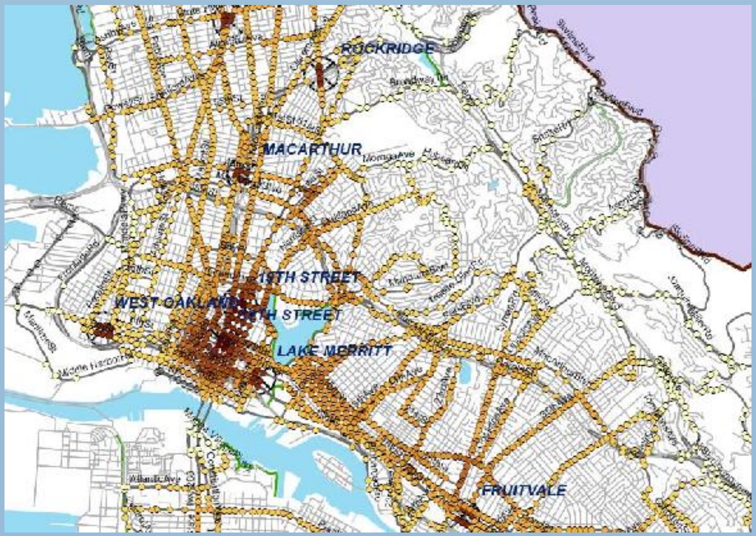
Percentage of Residents Under 18 (+)
A greater percentage of young pedestrians within 0.25 miles may indicate that more of the people crossing are less experienced and have higher risk crossing busy streets.

(Expected Effect: 1% more residents under 18: 7% more crashes)*

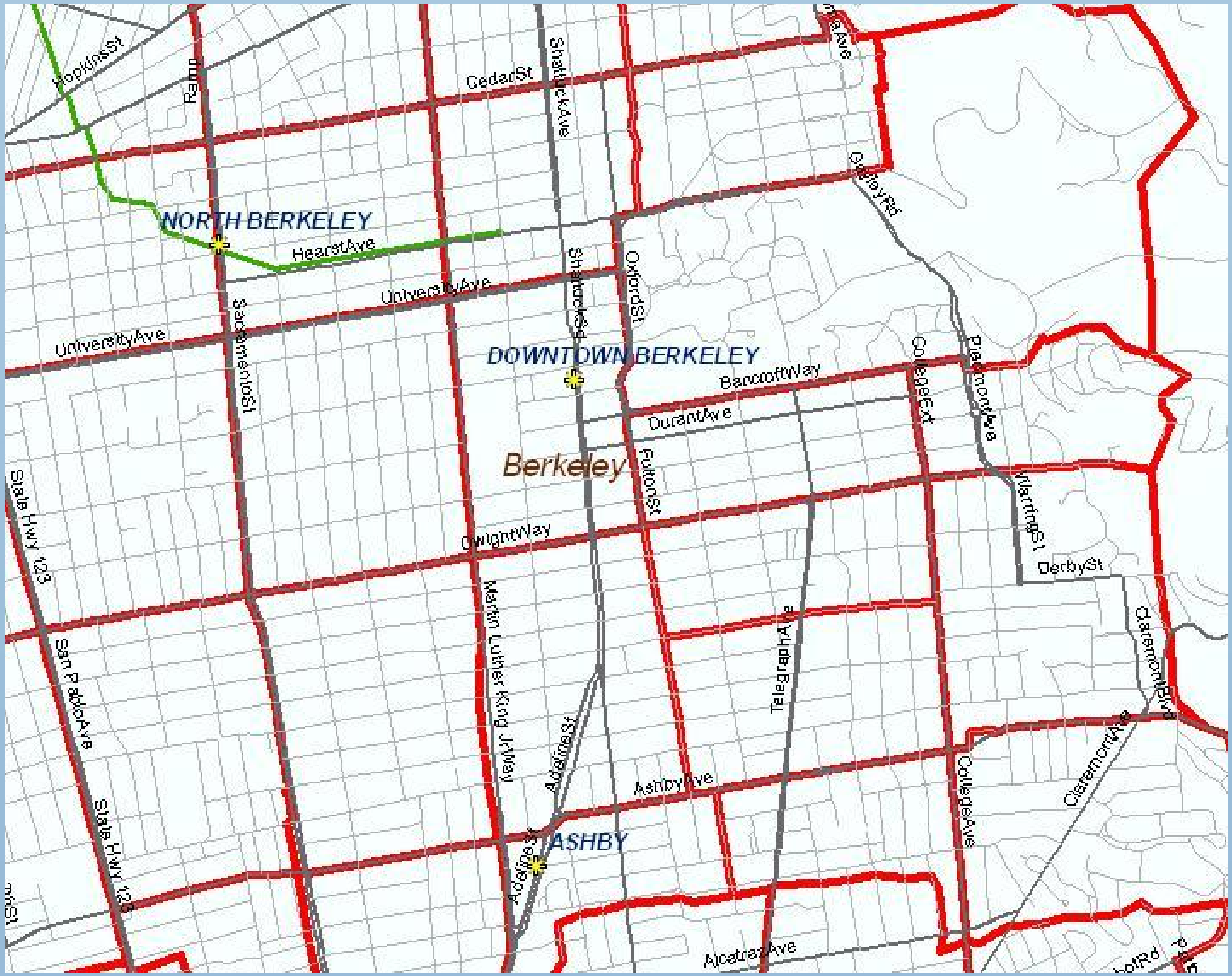
**Italics show the change in the expected number of pedestrian crashes at intersections with different features, in order to provide a frame of reference. These numbers are based on the model, which reflects the 81 Alameda County study intersections as a whole. The effect of any particular treatment is highly context specific.*

Many Demand Analysis Methods

- Traditional 4-step models
- Direct counts & surveys
- Sketch plan with expert-defined weights
- Network-based models
- Location-based models



The Traditional Four Step Model



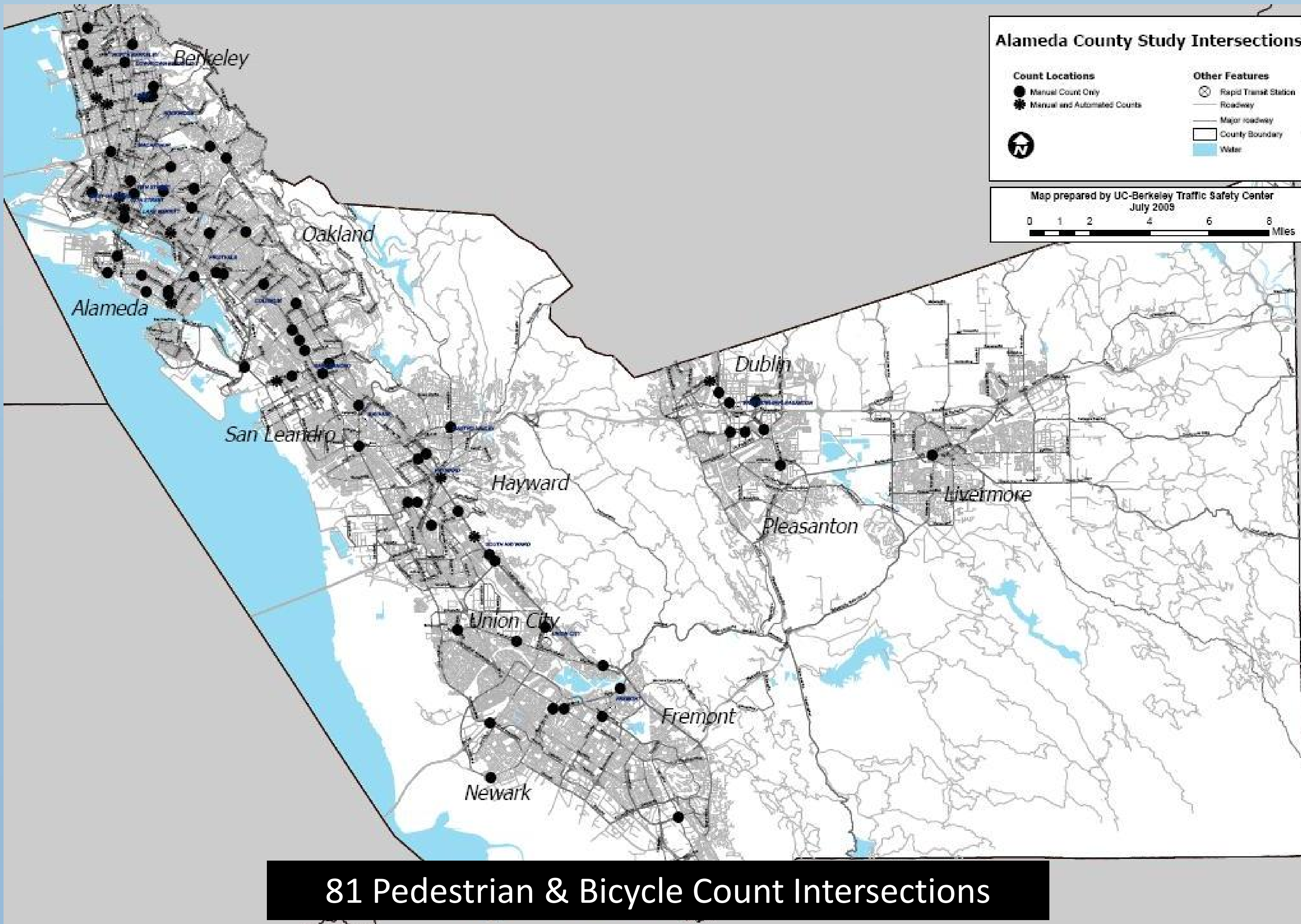
Berkeley, CA Traffic Analysis Zones

The Traditional Four Step Model

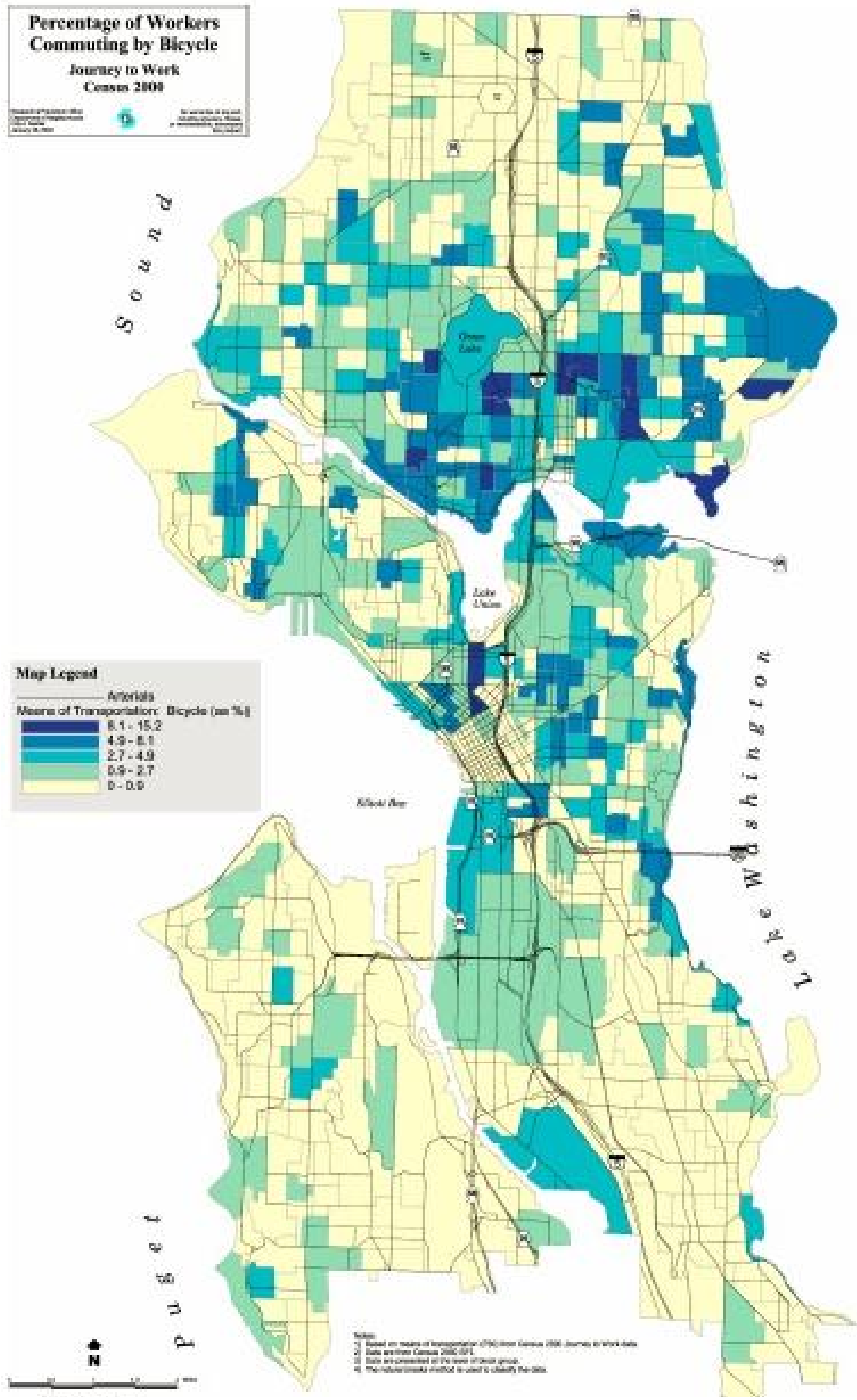
- Ignores trips that occur within zones (many short pedestrian & bicycle trips)
- Misses “secondary” trip modes (e.g., walk from parking or walk to transit)

Berkeley, CA Traffic Analysis Zones

Pedestrian & Bicycle Counts



81 Pedestrian & Bicycle Count Intersections

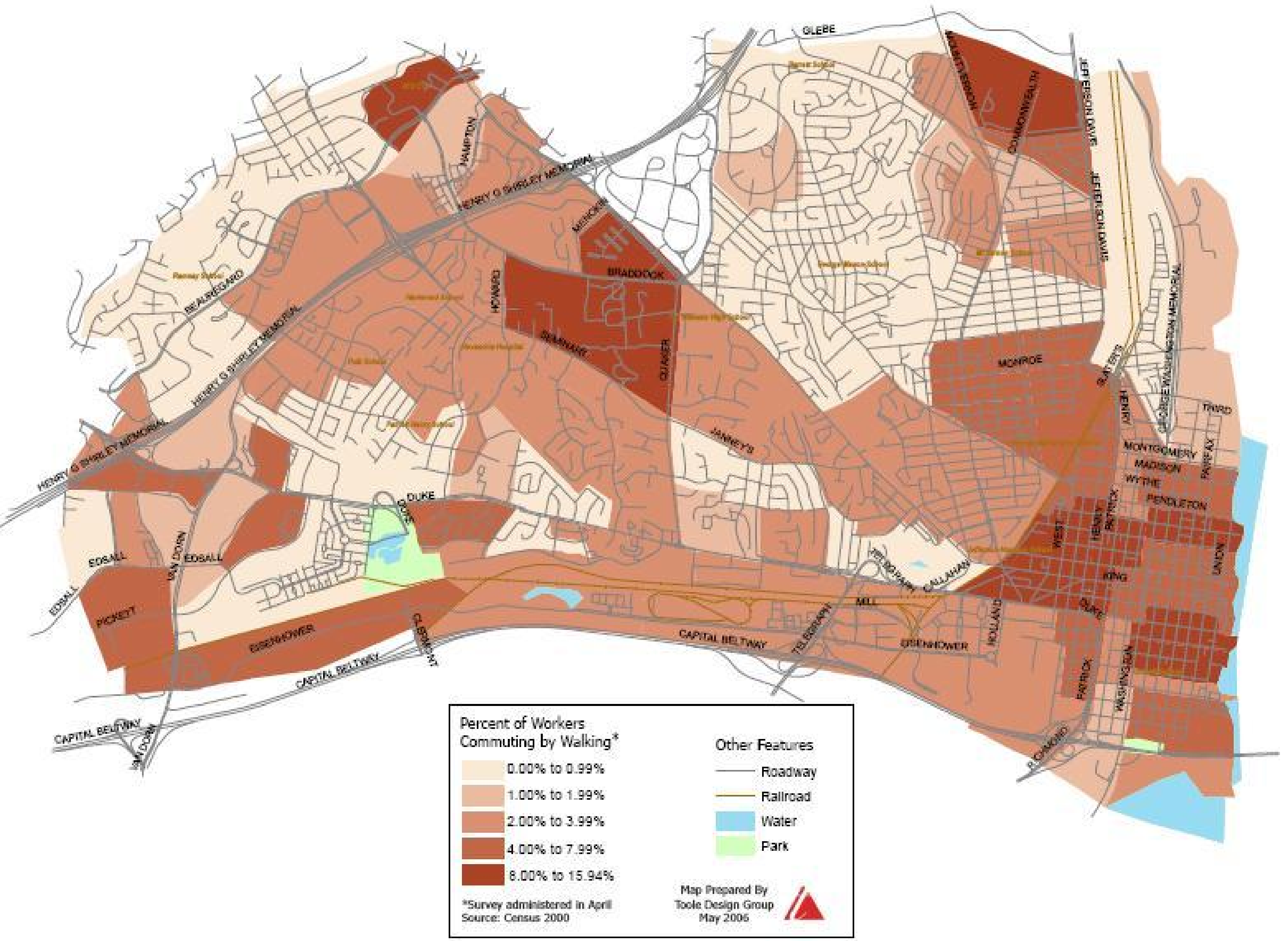


Census/ACS Data

Source: City of Seattle Bicycle Master Plan, 2007

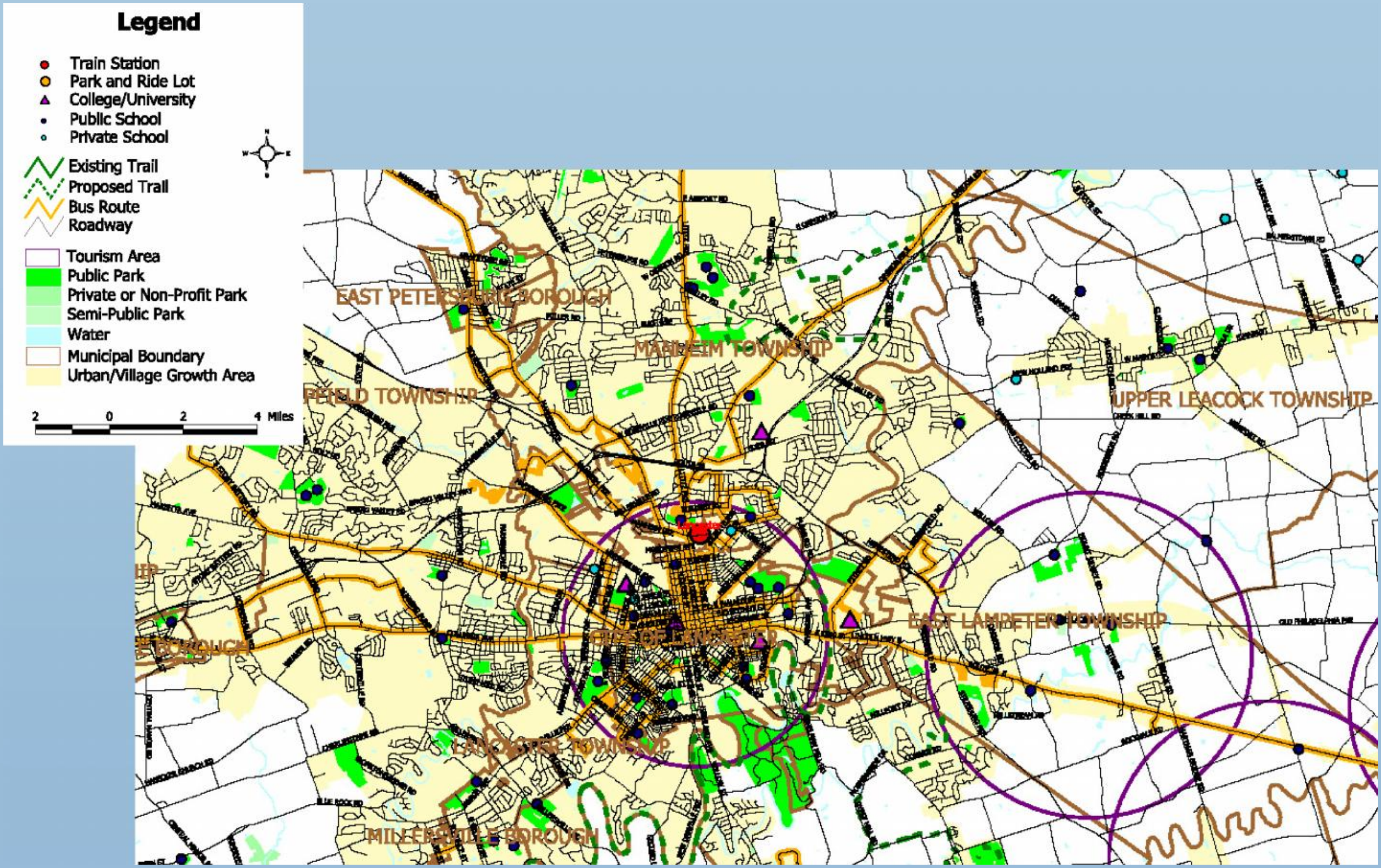
Census/ACS Data

City of Alexandria--Pedestrian Commuting



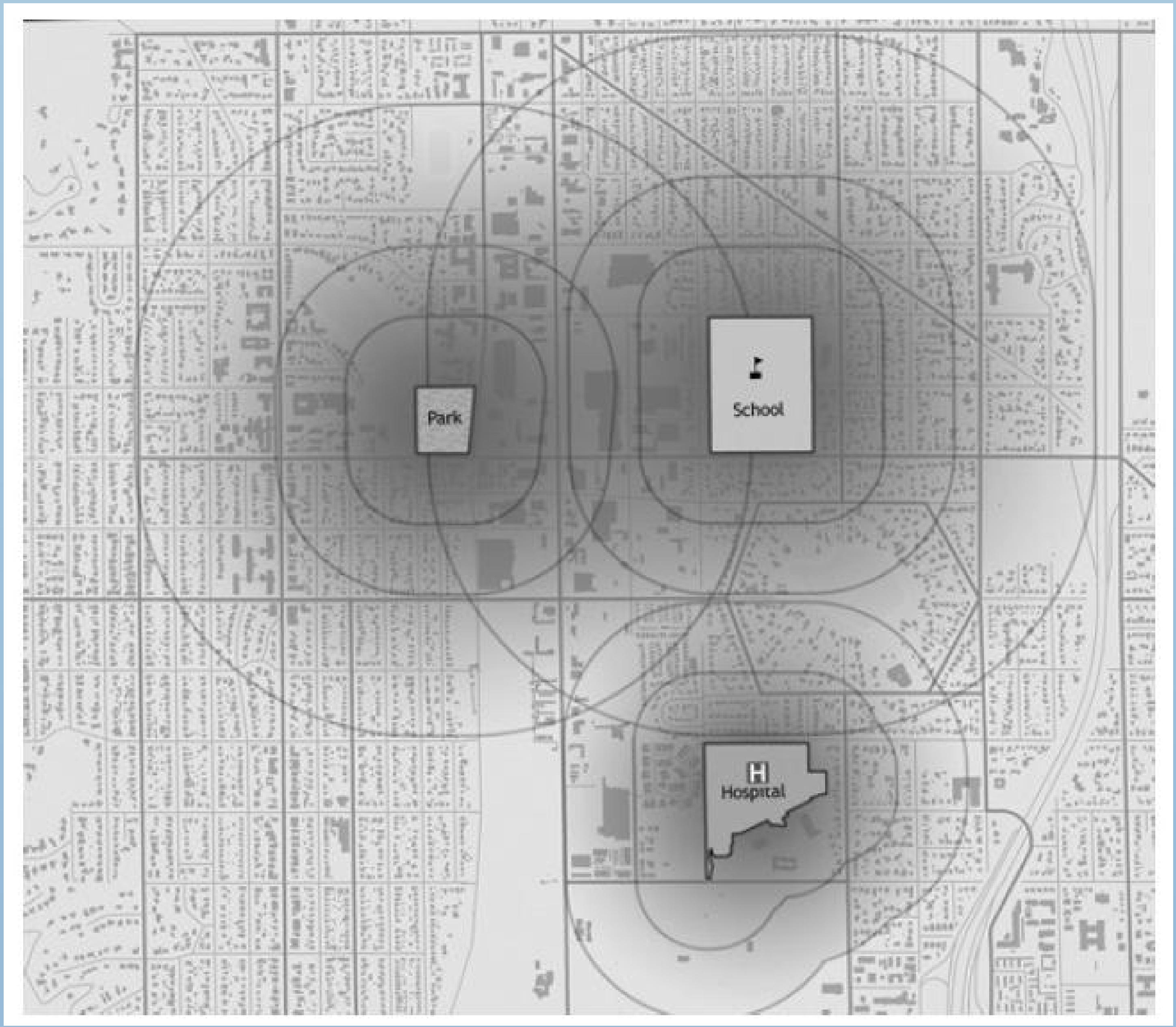
Source: City of Alexandria, VA Pedestrian and Bicycle Mobility Plan, 2008

Sketch Plan Methods



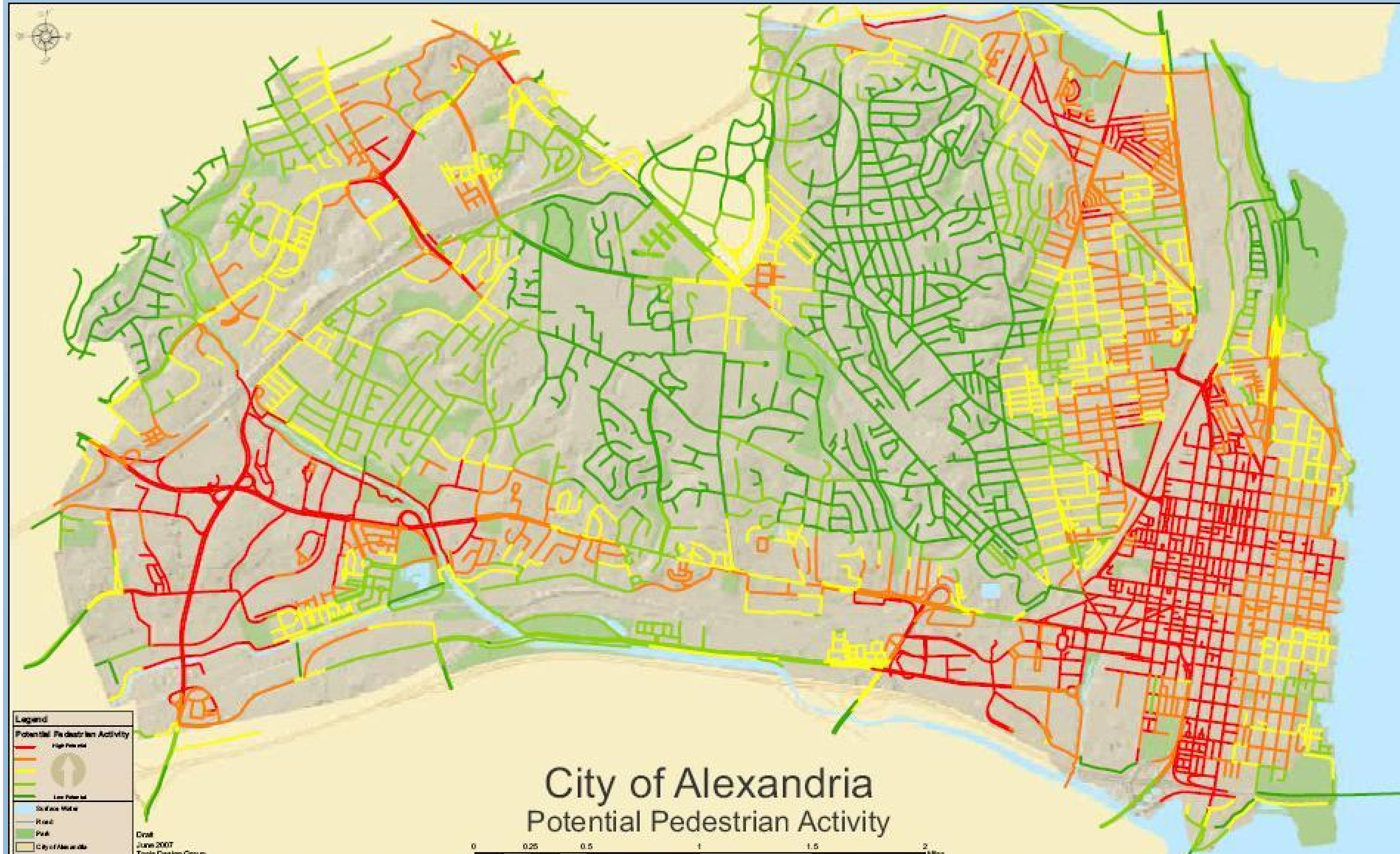
Source: Lancaster County Pedestrian and Bicycle Transportation Plan, Phase II, 2004

Sketch Plan Methods



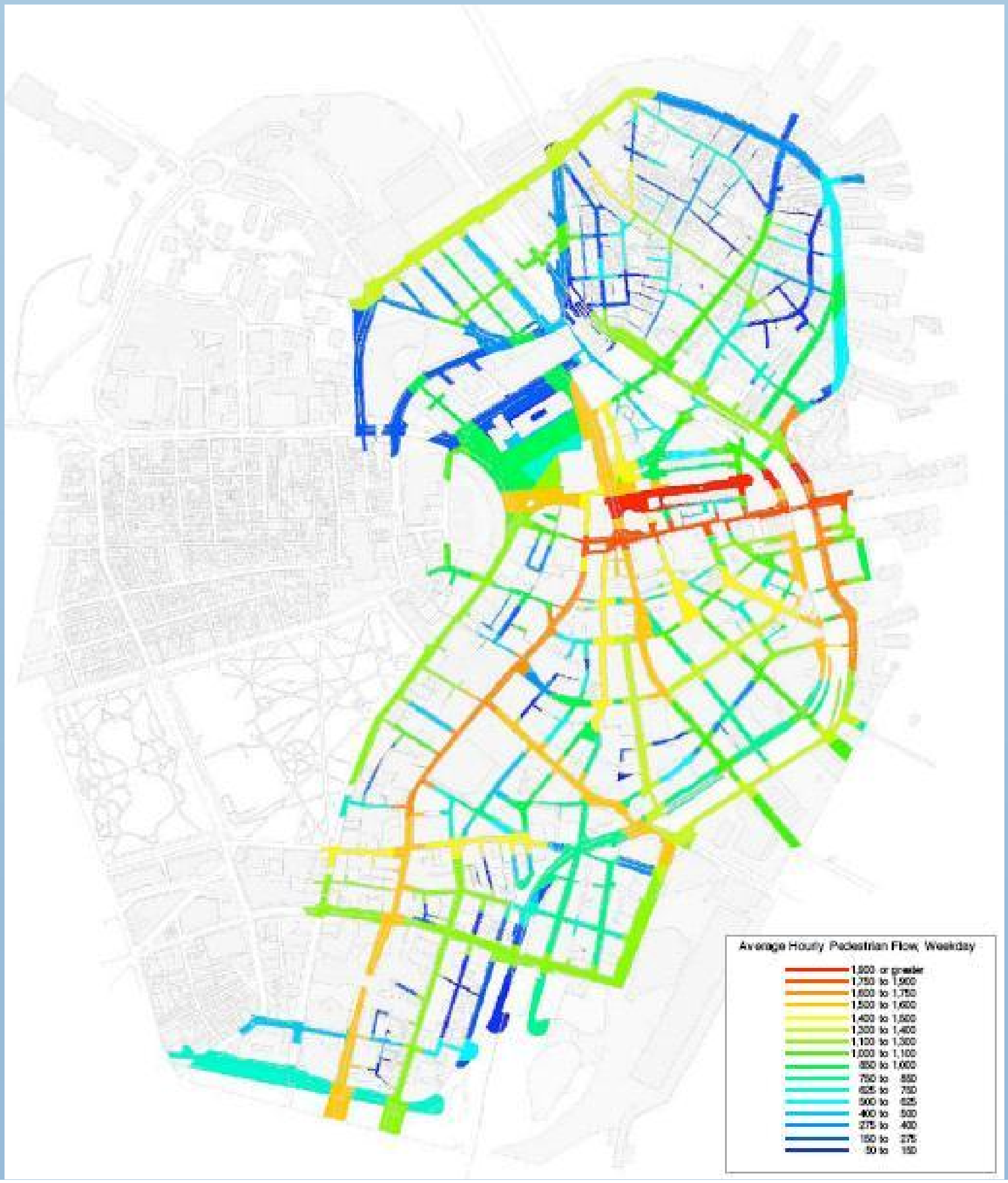
Source: Goodman, D., R. Schneider, and T. Griffiths. "Put Your Money where the People Are," *Planning*, June 2009.

Sketch Plan Methods



Source: City of Alexandria, VA Pedestrian and Bicycle Mobility Plan, 2008

Network-Based Model: Space Syntax

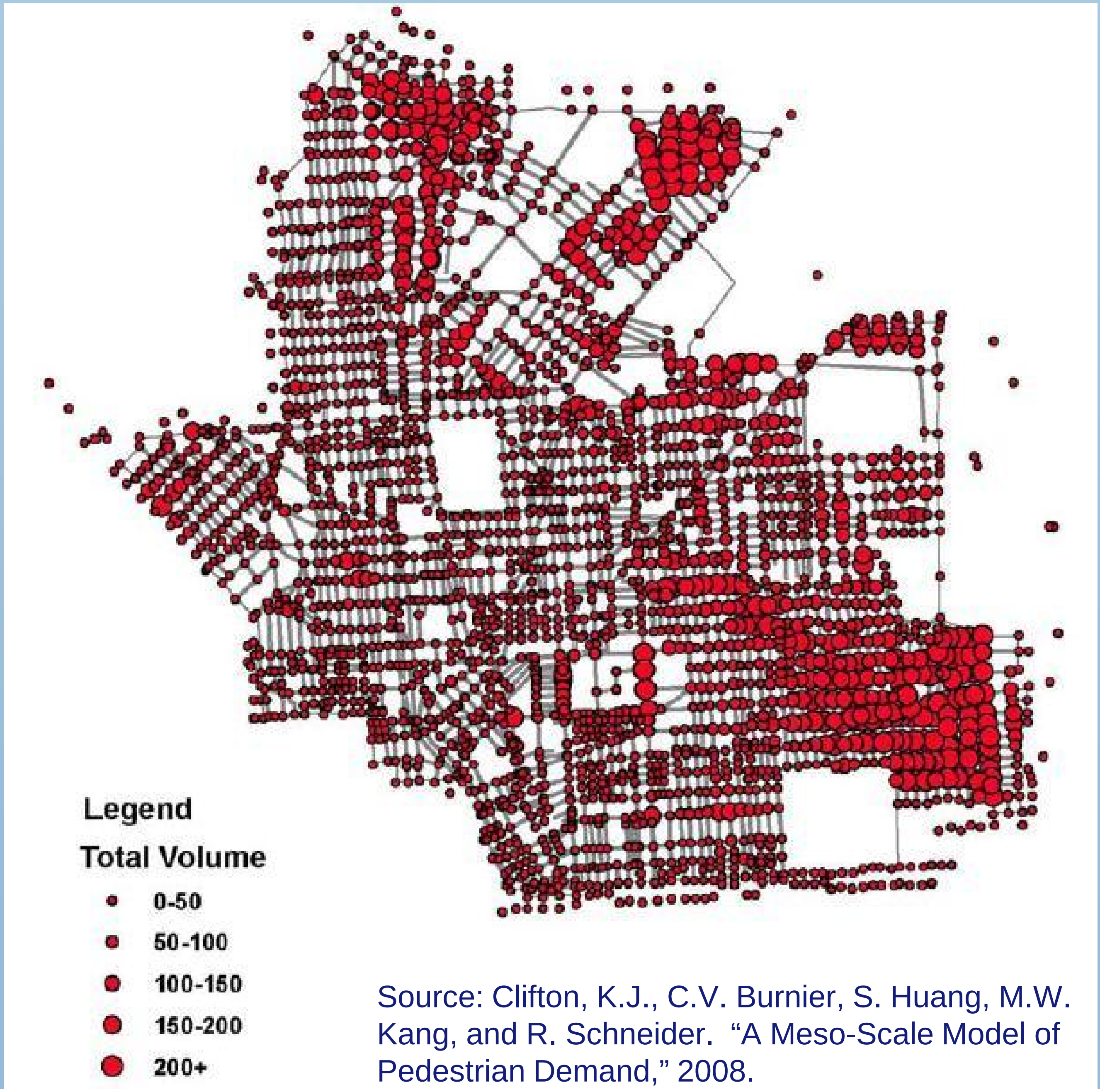


- Street and path networks (potential movement patterns)
- Viewsheds
- Fathom Visibility Graph Analysis Software

Downtown Boston

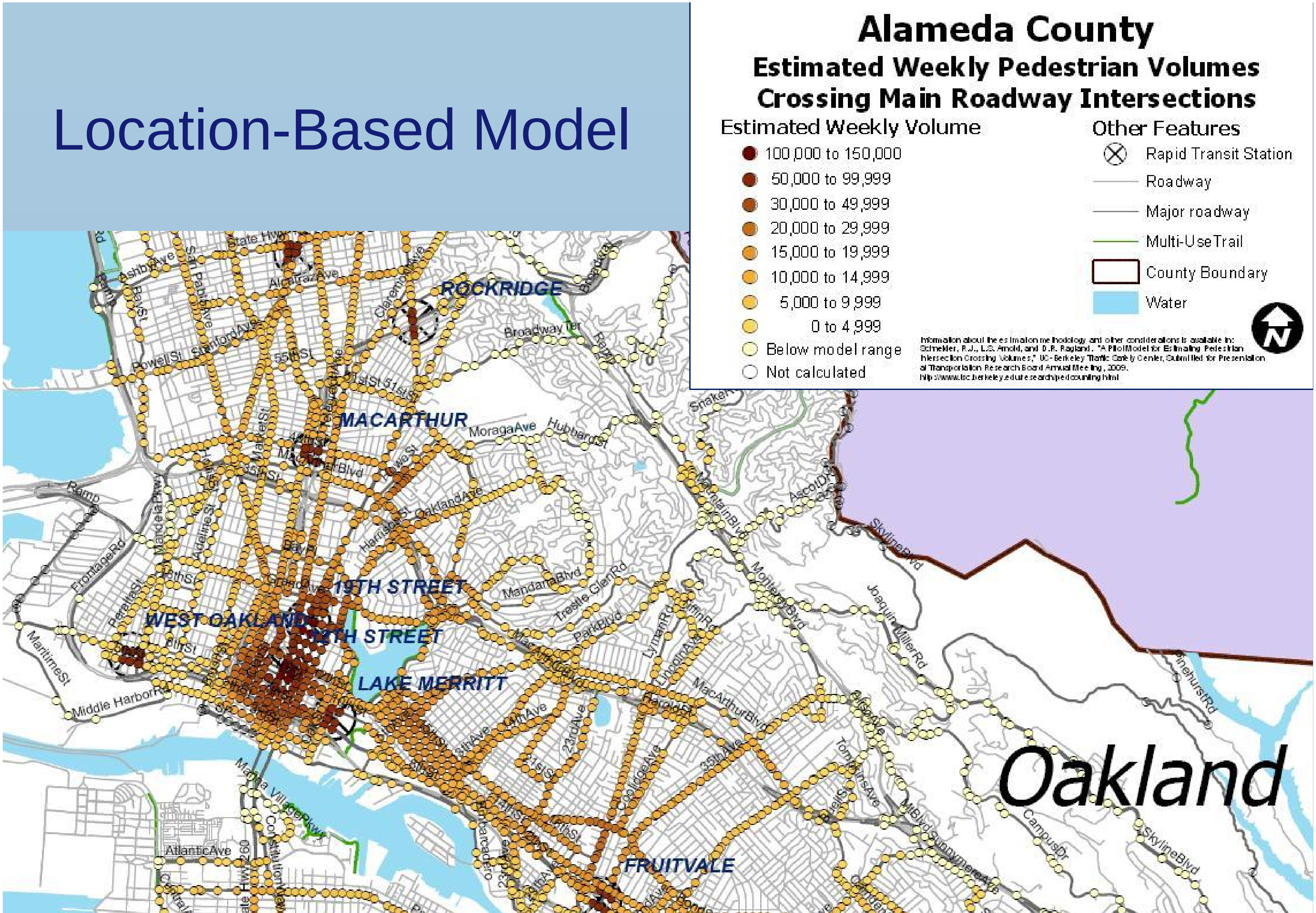
Source: Raford and Ragland. *Pedestrian Volume Modeling For Traffic Safety & Exposure Analysis*, 2005.

Network-Based Model: Clifton Maryland Ped Model



Source: Clifton, K.J., C.V. Burnier, S. Huang, M.W. Kang, and R. Schneider. “A Meso-Scale Model of Pedestrian Demand,” 2008.

Location-Based Model



Source: Schneider R.J., L.S. Arnold, and D.R. Ragland. “A Pilot Model for Estimating Pedestrian Intersection Crossing Volumes,” Transportation Research Record 2140, pp. 13-26, 2009.

Approach: Develop a model to estimate pedestrian intersection crossing volumes at different locations

Location-Based Models

- Schneider, *et al*. San Francisco pedestrian (2012)
- Miranda-Moreno, *et al*. Montreal pedestrian (2011)
- Griswold, Medury, & Schneider, Alameda County bicycle (2011)
- Fehr & Peers, Santa Monica pedestrian & bicycle (2010)
- Alta Planning + Design, San Diego pedestrian & bicycle (2010)
- Schneider, Arnold & Ragland, Alameda County pedestrian (2009)
- Liu & Griswold, San Francisco pedestrian (2009)
- Pulugurtha & Repaka, Charlotte pedestrian (2008)

Intersection-Based Pedestrian Models

TABLE 1 Examples of Previous Pedestrian Intersection Volume Models

General information		Pedestrian count information					Statistically-significant predictive variables				Model information		
Model Location	**Developed by**	**Intersections Used for Model**	**Pedestrian Count Description**	**Type of Count Sites**	**Count Period(s) Used for Model**	**Weather During Counts**	**Land Use**	**Transportation System**	**Socioeconomic Characteristics**	**Other**	**Model Output**	**Model Type**	**Validation Testing**
Charlotte, NC	UNC Charlotte (Pulugurtha & Repaka 2008)	176	Pedestrians counted each time they arrived at the intersection from any direction	Signalized intersections	7 am-7 pm	Clear weather conditions	• Pop. within 0.25 mi. • Jobs within 0.25 mi. • Mixed land use within 0.25 mi. • Urban residential area within 0.25 mi.	• Number of bus stops within 0.25 mi.			Total pedestrians approaching intersections from 7 am to 7 pm (shorter periods also modeled)	Linear	None reported
Alameda County, CA	UC Berkeley SafeTREC (Schneider, Arnold, & Ragland 2009)	50	Pedestrians counted every time they crossed a leg of the intersection (pedestrians within 50 feet of the crosswalk were counted)	Signalized and unsignalized intersections	Tu, W, or Th: 12-2 pm or 3-5 pm; Sa: 9-11 am, 12-2 pm, or 3-5 pm	All weather conditions; weather adjustment factors were calculated from automated counters	• Population within 0.5 mi. • Employment within 0.25 mi. • Commercial properties within 0.25 mi.	• BART (regional transit) station within 0.1 mi.			Total pedestrian crossings at intersections during a typical week	Linear	46 historic counts used for validation (30 additional intersections were counted for validation in 2009)
San Francisco, CA	San Francisco State (Liu & Griswold 2009)	63	Pedestrians counted each time they crossed a leg of the intersection (no distance to crosswalk specified)	Signalized and unsignalized intersections	Weekdays 2:30-6:30 pm	Not reported	• Population density (net) within 0.5 mi. • Employment density (net) within 0.25 mi. • Patch richness density within 0.063 mi. • Residential land use within 0.063 mi.	• MUNI (light-rail transit) stop density within 0.38 mi. • Presence of bike lane at intersection		• Mean slope within 0.063 mi.	Total pedestrian crossings at intersections from 2:30-6:30 pm on typical weekday	Linear	None reported
Santa Monica, CA	Fehr & Peers (Haynes *et al.* 2010)	92	Pedestrians counted each time they crossed a leg of the intersection (no distance to crosswalk specified)	Signalized and unsignalized intersections	Weekdays 5-6 pm	Not reported	• Employment density within 0.33 mi. • Within a commercially-zoned area	• Afternoon bus frequency • Average speed limit on the intersection approaches		• Distance from Ocean	Total pedestrian crossings at intersections from 5-6 pm on typical weekday	Linear	Approximately 107 additional intersections were counted for validation
San Diego, CA	Alta Planning + Design (Jones *et al.* 2010)	80	Pedestrians counted each time they arrived at the intersection from any direction	Signalized and unsignalized intersections (includes some trail/roadway intersections)	Weekdays 7-9 am	Nice weather	• Population density within 0.25 mi. • Employment density within 0.5 mi. • Presence of retail within 0.5 mi.	• Greater than 6,000 transit ridership at bus stops within 0.25 mi. • 4 or more Class I bike paths within 0.25 mi.	• More than 100 households without vehicles within 0.5 mi.		Total pedestrians approaching intersections from 7 am to 9 am	Log-linear	None reported
Montreal, Quebec	McGill University (Miranda-Moreno & Fernandes 2011)	1018	Pedestrians counted each time they crossed a leg of the intersection (no distance to crosswalk specified)	Signalized intersections	Weekdays 6-9 am, 11 am-1 pm, and 3:30-6:30 pm	Most counts during nice weather; weather variables were analyzed	• Population within 400 m • Commercial space within 50 m • Open space within 150 m • Schools within 400 m	• Subway within 150 m • Bus station within 150 m • % Major arterials within 400 m • Street segments within 400 m • 4-way intersection		• Distance to downtown • Daily high temperature >32°C	Total pedestrian crossings at intersections over 8 count hours (shorter periods also modeled)	Log-linear (also used Negative binomial)	Counts at 20% of the intersections were compared to a model based on 80% of the intersections for validation

Schneider, R.J., et al. "Development and Application of the San Francisco Pedestrian Intersection Volume Model" (2012)

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Schneider, R.J., et al. "Development and Application of the San Francisco Pedestrian Intersection Volume Model" (2012)

Example: Development of the Alameda County Pedestrian Volume Model

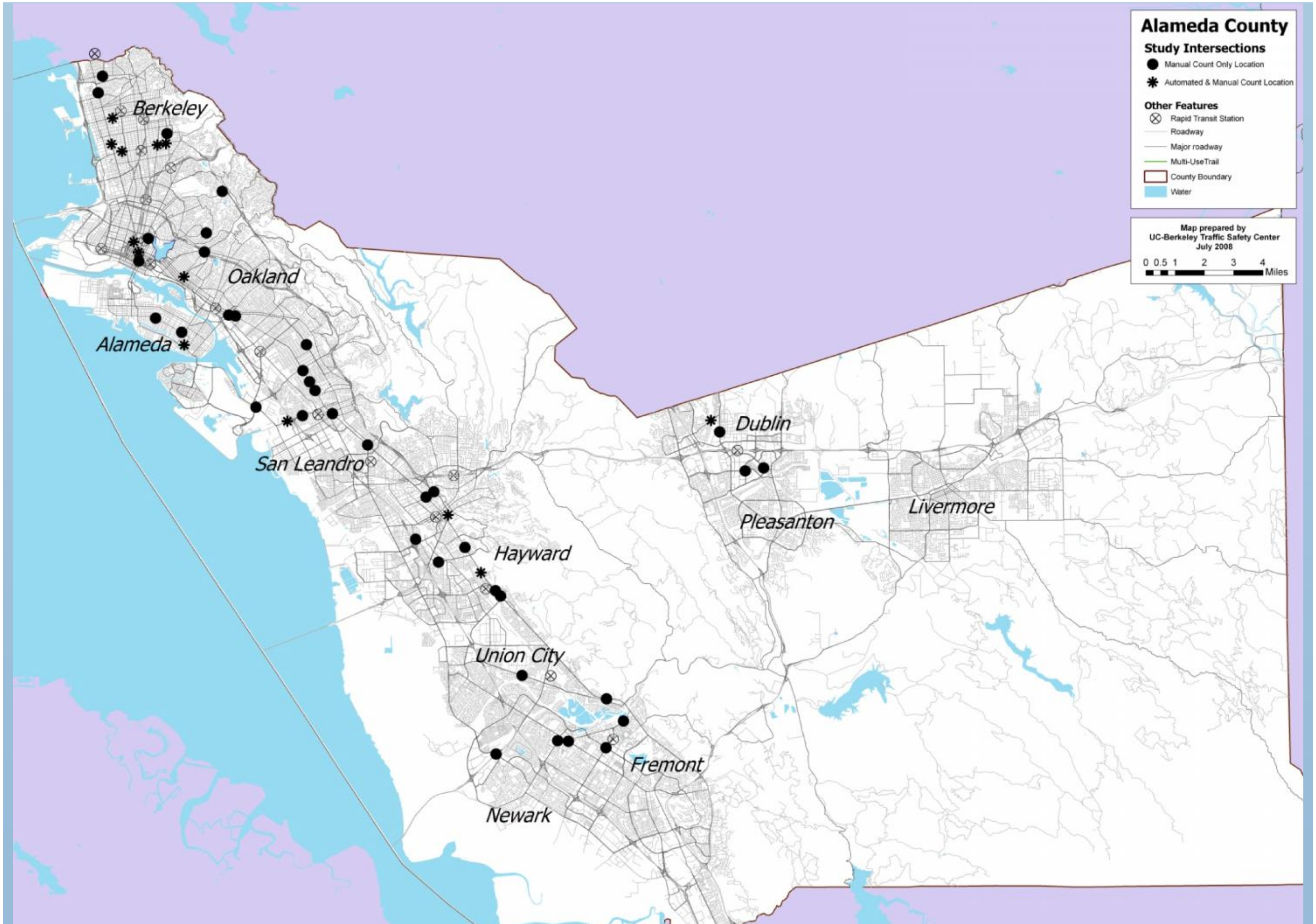
Source: Schneider R.J., L.S. Arnold, and D.R. Ragland. “A Pilot Model for Estimating Pedestrian Intersection Crossing Volumes,” Transportation Research Record 2140, pp. 13-26, 2009.

Pedestrian Model Development

- Sample of intersections along arterial and collector roadways
- Pilot Model: April to June 2008 (N=50)
- Validation: April to June 2009 (N=30)

2008 Location Selection Process

- All Possible Intersections = 7,466
- Choose 50 Intersections
  - Ensure a wide variety of characteristics are represented
  - Ensure a wide geographic distribution
- Restrictions
  - No intersections with low pop. density, no grade separated crossings, no intersections within ¼-mile of county line
  - Include at least 2 trail/roadway crossings & 3 CBD intersections



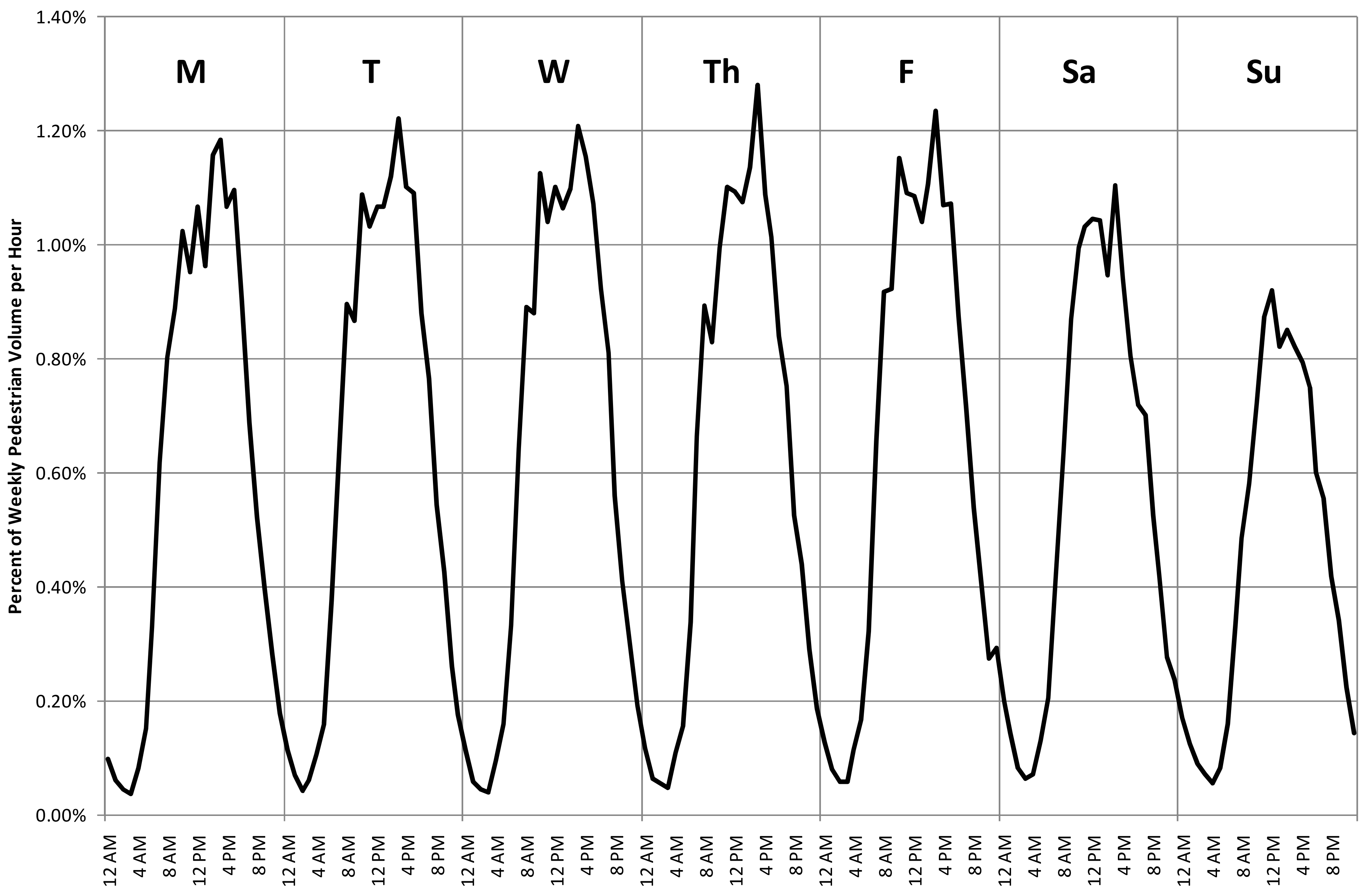
50 Intersections Counted in 2008

Pilot Model Pedestrian Volume Data

- Pedestrian crossings within 50 feet of each study intersection
- 2-hour manual counts (Weekday & Saturday)
- April to June 2008
- Counts extrapolated and adjusted for land use & weather

Example automated counter location: Broadway & 12th Street (Oakland)

"Typical" Alameda County Pedestrian Activity Pattern



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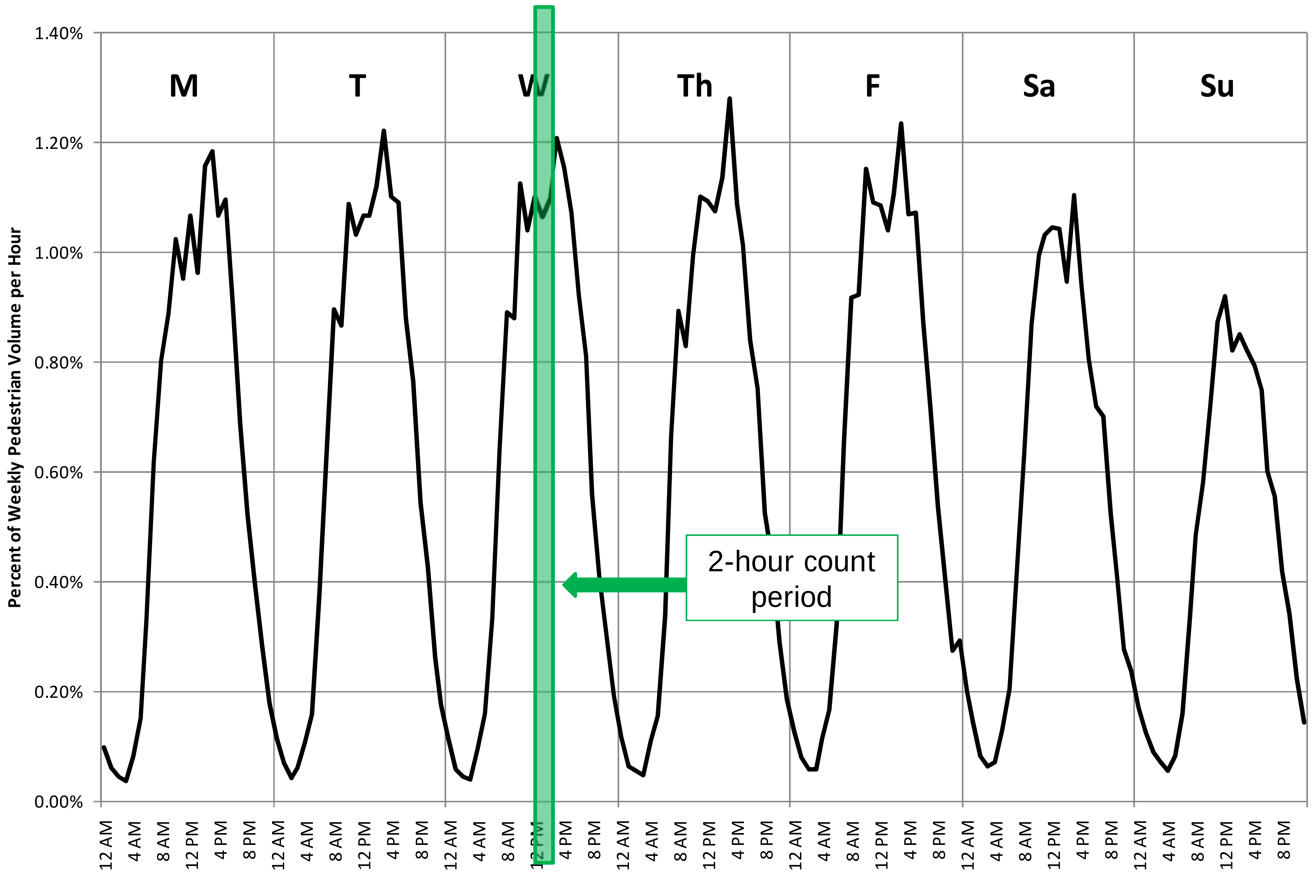
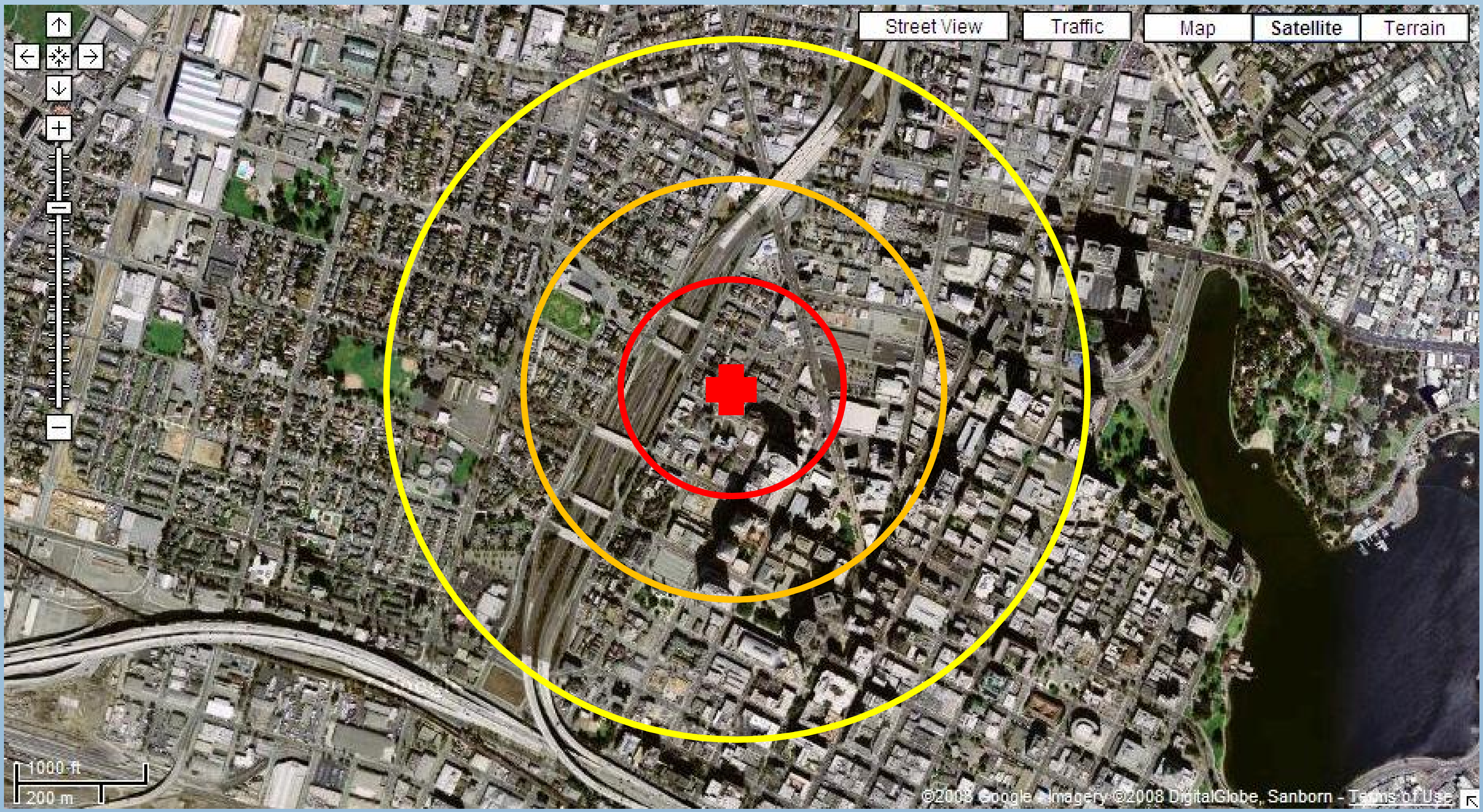


One study intersection: Martin Luther King Jr. Wy. & 17th St., Oakland



Approximately 5,600 pedestrian crossings per week (Spring 2008)

Alameda County Pilot Model

Estimated Weekly Pedestrian Crossings =

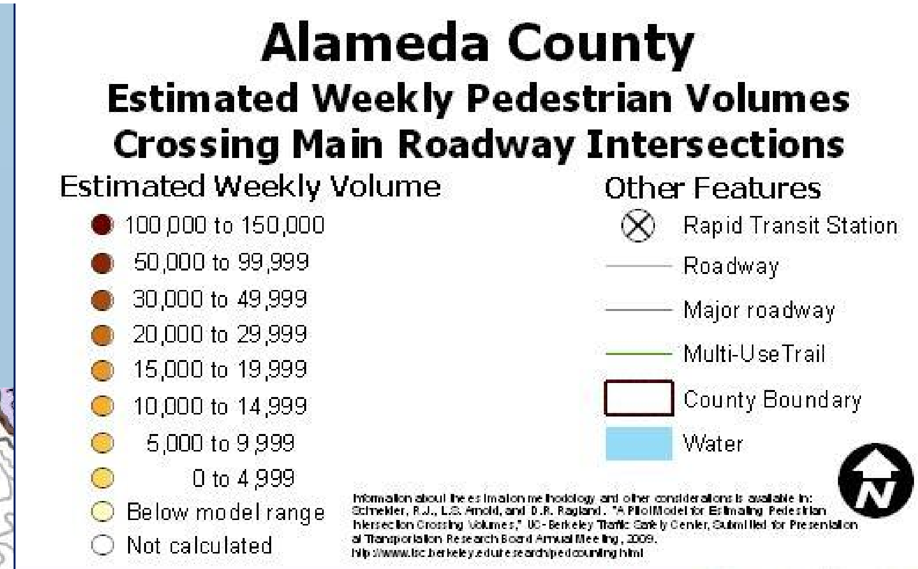
	0.928	*	Total population within 0.5-miles of the intersection
+	2.19	*	Total employment within 0.25-miles of the intersection
+	98.4	*	Number of commercial properties within 0.25-miles of the intersection
+	54,600	*	Number of regional transit stations within 0.10-miles of the intersection
-	4910		(Constant)

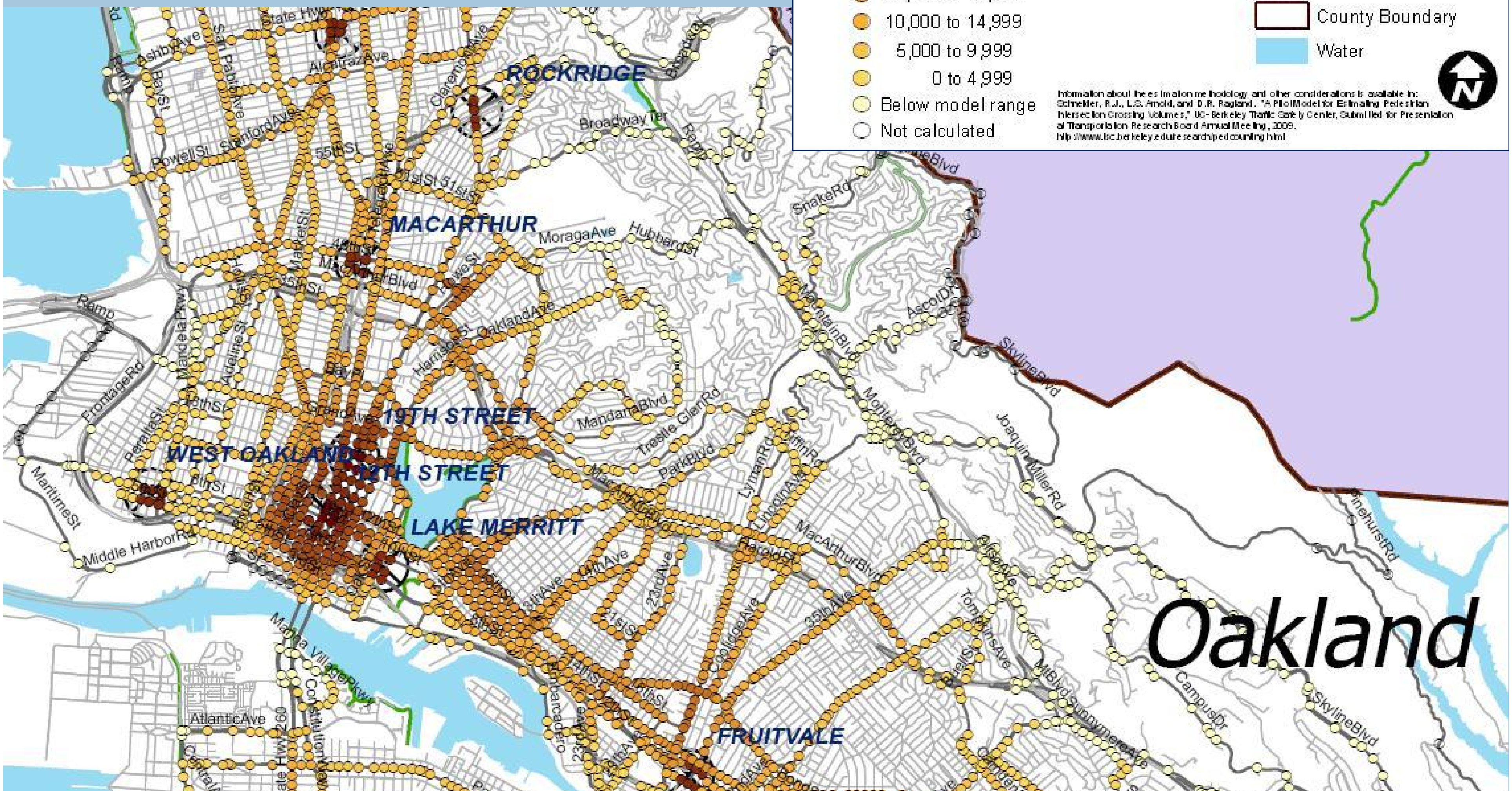
Adjusted $R^2 = 0.897$

Root Mean Squared Error = 5760

Explanatory variables significant at 95% confidence interval

Pilot Pedestrian Volume Model Application





Alameda County Pedestrian Volume Forecasting Spreadsheet

Pedestrian Intersection Crossing Volume Model

Pilot Model--January 2009[1,2]

Developed by Robert Schneider, Lindsay Arnold, and David Ragland
University of California Berkeley Safe Transportation Research & Education Center

Intersection Identification			*Model Inputs* [4]				*Model Output*
Mainline Roadway	Intersecting Roadway	City	Total **population** within 1/2-mile radius[3]	Total **employment** within 1/4-mile radius	Total number of **commercial properties** within 1/4-mile radius	Presence of **regional transit station** within 1/10 mile (Yes = 1, No = 0)	**Estimated Pedestrian Crossings in a Typical Week**[5,6,7]
Telegraph Avenue	59th Street	Oakland	10270	610	27	0	**8542**

Notes:

1. This is a revised version of the pilot model of weekly pedestrain volumes at 50 intersections in Alameda County, CA. The model has a good fit for the Alameda County study data (adjusted-R^2=0.900). Since the analysis was conducted on 50 intersections in Alameda County, CA, more research is needed to refine the model equation and determine the applicability of the results for other communities. The model equation is: Estimated pedestrian intersection crossings per week = 0.987 * Total population within 0.5-miles of the intersection + 2.19 * Total employment within 0.25-miles of the intersection + 71.1 * Number of commercial retail properties within 0.25-miles of the intersection + 49,300 * Number of regional transit stations within 0.10-miles of the intersection - 4850. Details of the study are provided in two papers: 1) Schneider, R.J., L.S. Arnold, and D.R. Ragland. "Extrapolating Weekly Pedestrian Intersection Crossing Volumes from 2-Hour Manual Counts," UC-Berkeley Traffic Safety Center, Transportation Research Record, 2010, and 2) Schneider R.J., L.S. Arnold, and D.R. Ragland. "A Pilot Model for Estimating Pedestrian Intersection Crossing Volumes," UC-Berkeley Traffic Safety Center, Transportation Research Record, 2010.
2. The pedestrian volume estimates produced by the model are intended for planning, prioritization, and safety analysis at the community, neighborhood, and corridor levels. Since the model provides rough estimates of pedestrian activity, actual pedestrian counts should be used for site-level safety, design, and engineering analyses.
3. The intersections selected for the study did not include intersections in areas with very low population densities (<50 people per square mile). Therefore, the model is not appropriate for intersections below this density threshold (i.e., the model does not apply if there are fewer than 64 people within a 1/2-mile radius).
4. The study of Alameda County, CA found that land use characteristics are the most important factors for predicting pedestrian activity. Roadway design factors, such as the presence of sidewalks, median crossing islands, curb radii, or pedestrian crossing signals may have minor effects on pedestrian volumes, but they are not as significant for predicting pedestrian activity. However, roadway design factors are critical for pedestrian safety and comfort. Roadways must be designed to accommodate pedestrians of all abilities, regardless of volume.
5. The model output is an estimate of the number of pedestrian crossings during a typical 168-hour week (with an average seasonal volume). Pedestrian crossings are counted each time a pedestrian crosses any leg of the intersection (e.g., one person is counted twice if they cross the east leg and then the south leg of an intersection). Pedestrians do not need to cross completely inside the crosswalk; they are counted if if they cross within 50 feet of the intersection.
6. The model may not perform well in locations close to special attractors, such as amusement parks, waterfronts, sports arenas, regional recreation areas, and major multi-use

Alameda County Pedestrian Volume Forecasting Spreadsheet

Pedestrian Intersection Crossing Volume Model

Pilot Model--January 2009[1,2]

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University of California Berkeley Safe Transportation Research & Education Center

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Mainline Roadway	Intersecting Roadway	City	Total **population** within 1/2-mile radius[3]	Total **employment** within 1/4-mile radius	Total number of **commercial properties** within 1/4-mile radius	Presence of **regional transit station** within 1/10 mile (Yes = 1, No = 0)	**Estimated Pedestrian Crossings in a Typical Week[5,6,7]**
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Telegraph Avenue	59th Street	Oakland	20540	1220	27	0	**20014**

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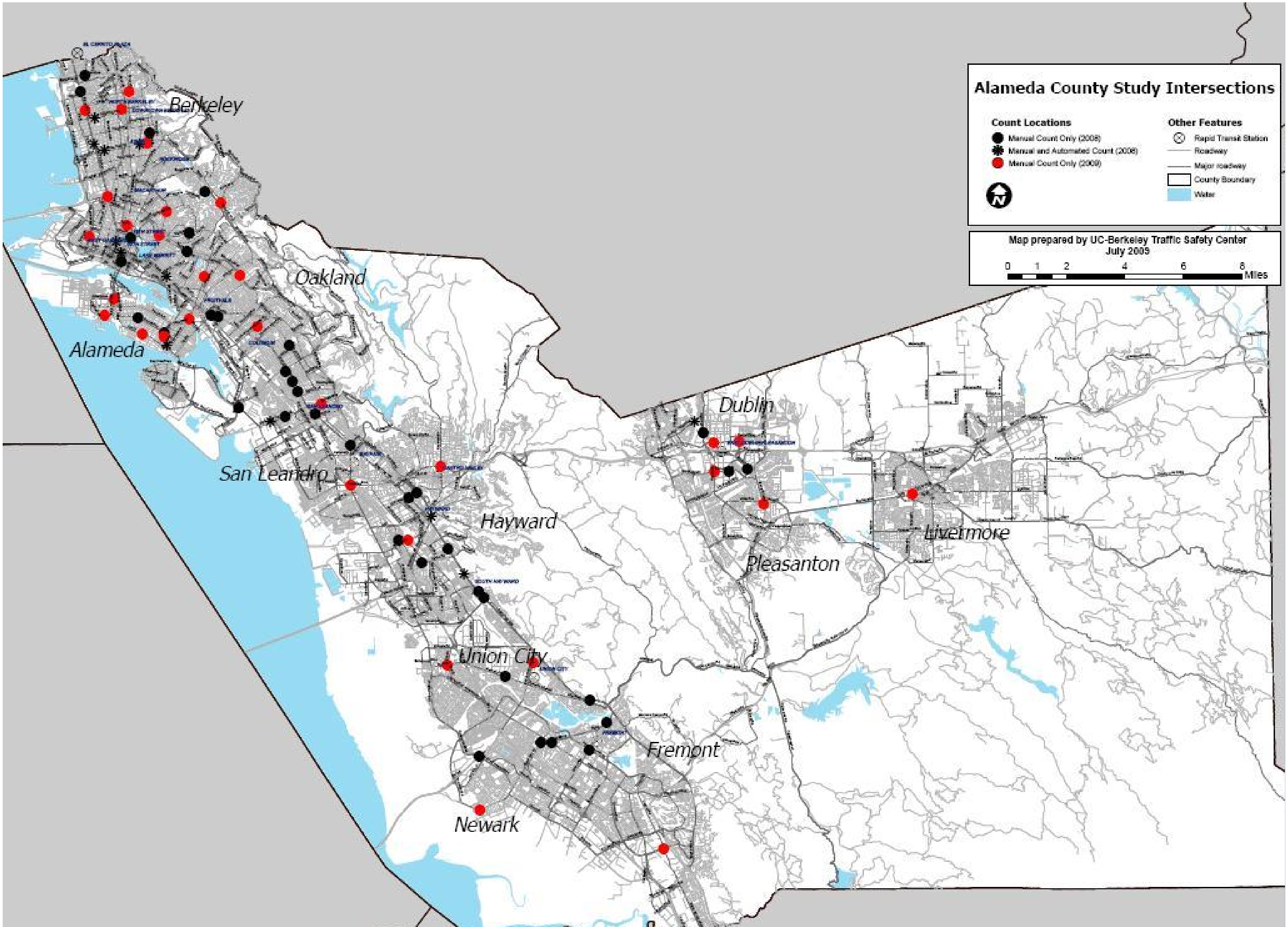
Telegraph Avenue	59th Street	Oakland	20540	1220	100	0	**25205**

Notes:

1. This is a revised version of the pilot model of weekly pedestrain volumes at 50 intersections in Alameda County, CA. The model has a good fit for the Alameda County study data (adjusted-R^2=0.900). Since the analysis was conducted on 50 intersections in Alameda County, CA, more research is needed to refine the model equation and determine the applicability of the results for other communities. The model equation is: Estimated pedestrian intersection crossings per week = 0.987 * Total population within 0.5-miles of the intersection + 2.19 * Total employment within 0.25-miles of the intersection + 71.1 * Number of commercial retail properties within 0.25-miles of the intersection + 49,300 * Number of regional transit stations within 0.10-miles of the intersection - 4850. Details of the study are provided in two papers: 1) Schneider, R.J., L.S. Arnold, and D.R. Ragland. "Extrapolating Weekly Pedestrian Intersection Crossing Volumes from 2-Hour Manual Counts," UC-Berkeley Traffic Safety Center, Transportation Research Record, 2010, and 2) Schneider R.J., L.S. Arnold, and D.R. Ragland. "A Pilot Model for Estimating Pedestrian Intersection Crossing Volumes," UC-Berkeley Traffic Safety Center, Transportation Research Record, 2010.
2. The pedestrian volume estimates produced by the model are intended for planning, prioritization, and safety analysis at the community, neighborhood, and corridor levels. Since the model provides rough estimates of pedestrian activity, actual pedestrian counts should be used for site-level safety, design, and engineering analyses.
3. The intersections selected for the study did not include intersections in areas with very low population densities (<50 people per square mile). Therefore, the model is not appropriate for intersections below this density threshold (i.e., the model does not apply if there are fewer than 64 people within a 1/2-mile radius).
4. The study of Alameda County, CA found that land use characteristics are the most important factors for predicting pedestrian activity. Roadway design factors, such as the presence of sidewalks, median crossing islands, curb radii, or pedestrian crossing signals may have minor effects on pedestrian volumes, but they are not as significant for predicting pedestrian activity. However, roadway design factors are critical for pedestrian safety and comfort. Roadways must be designed to accommodate pedestrians of all abilities, regardless of volume.
5. The model output is an estimate of the number of pedestrian crossings during a typical 168-hour week (with an average seasonal volume). Pedestrian crossings are counted each time a pedestrian crosses any leg of the intersection (e.g., one person is counted twice if they cross the east leg and then the south leg of an intersection). Pedestrians do not need to cross completely inside the crosswalk; they are counted if if they cross within 50 feet of the intersection.
6. The model may not perform well in locations close to special attractors, such as amusement parks, waterfronts, sports arenas, regional recreation areas, and major multi-use

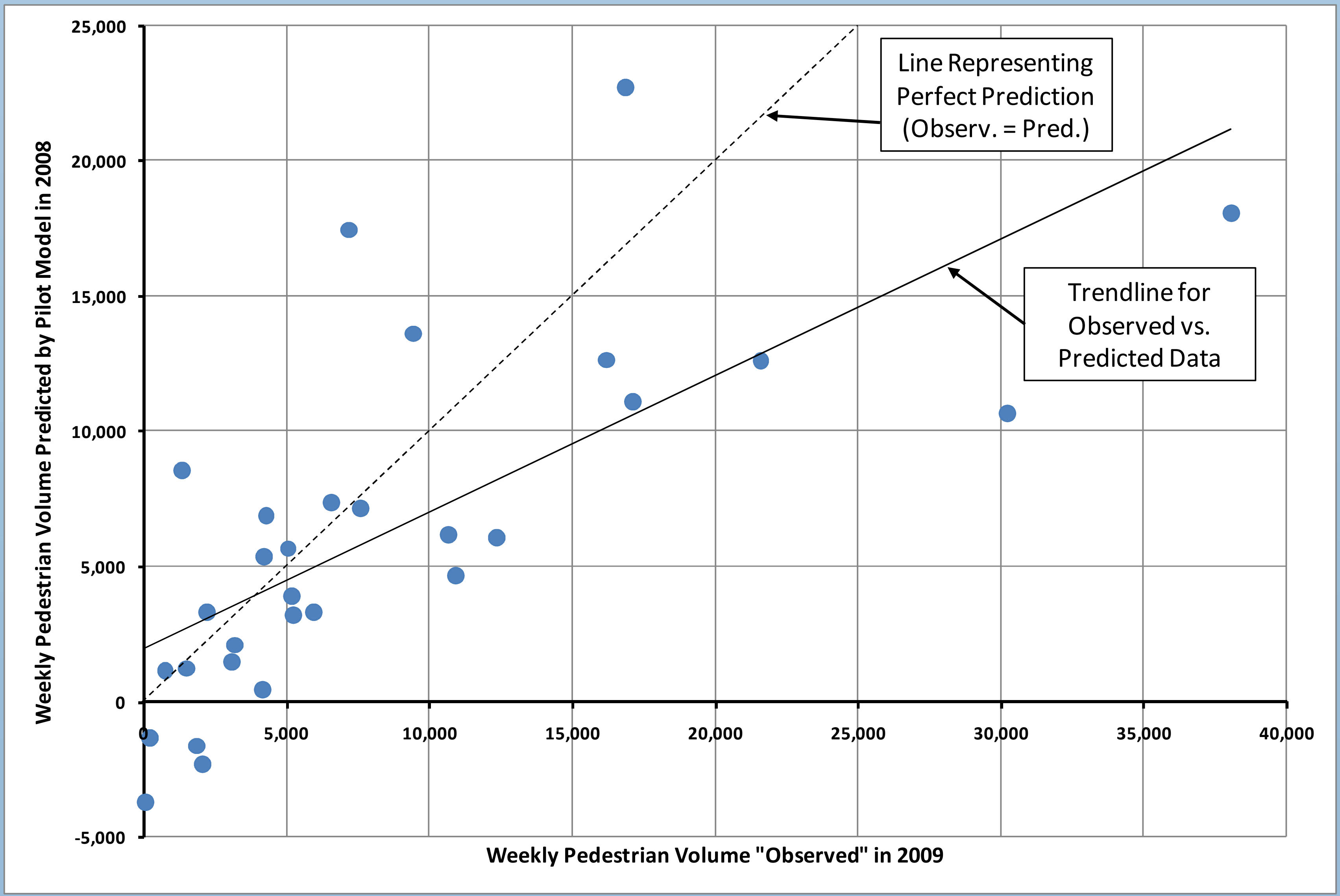


36 Intersections Counted in 2009 (Red)

Validation Analysis

- Compared pilot model estimated volume with “actual” volume at 30 intersections in 2009
  - Where did the Pilot model work well?
  - Where did the Pilot model overestimate volumes?
  - Where did the Pilot model underestimate volumes?
- Model tended to underestimate
- Issue with some negative predictions at low-volume intersections

2009 Observed Volumes vs. Pilot Model Predictions



Variation in Pedestrian Volumes

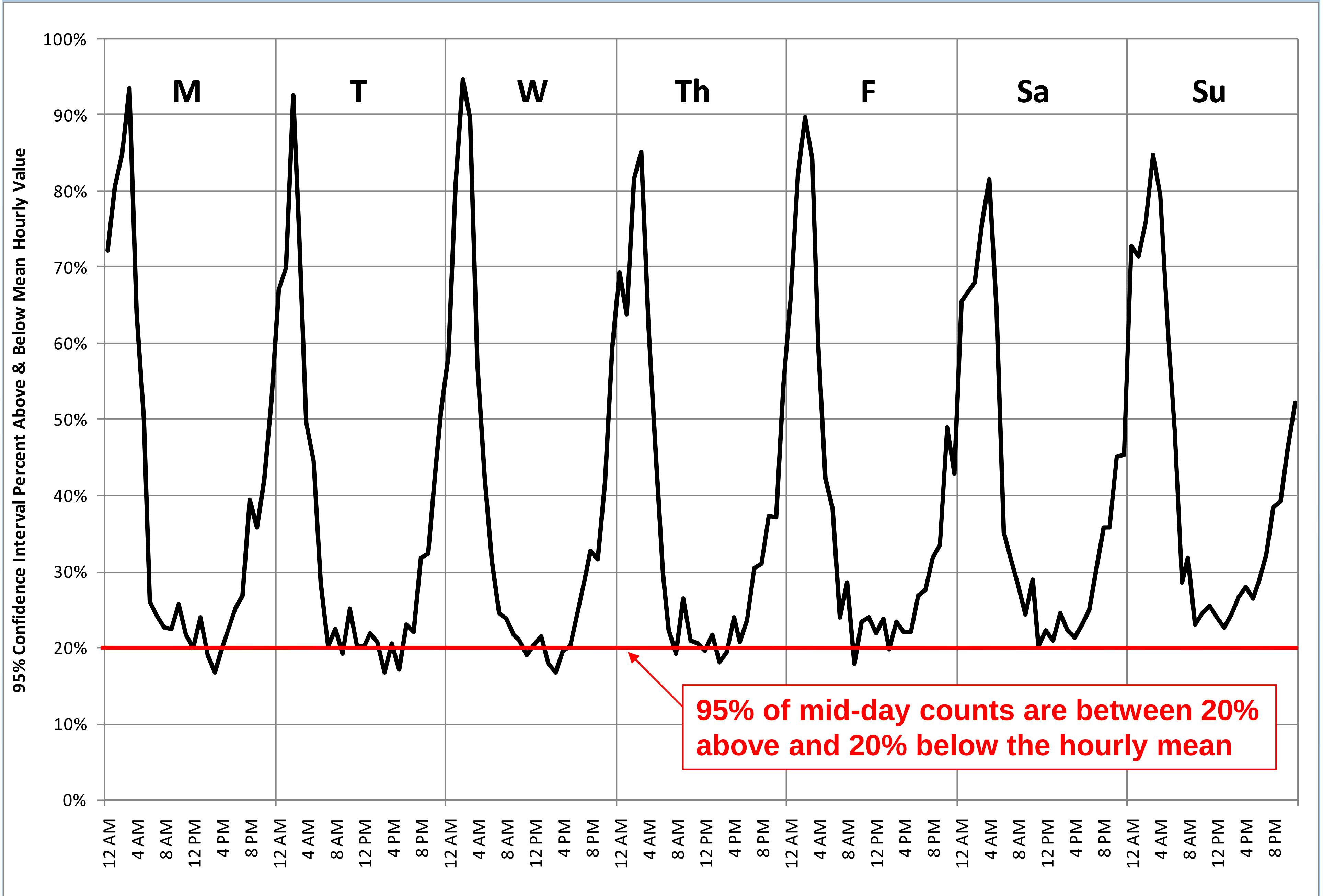
Variation in Pedestrian Volumes

- 5 Control Intersections

ID #	2008 Weekly Pedestrian Volume based on Counts	2009 Weekly Pedestrian Volume based on Counts	Absolute Difference (2009 - 2008)	Percent Difference[1]
50	315	310	-5	1.6%
2650	15691	16113	422	2.7%
9179	8342	7429	-913	12.3%
9436	105297	88118	-17179	19.5%
499	5186	3448	-1738	50.4%

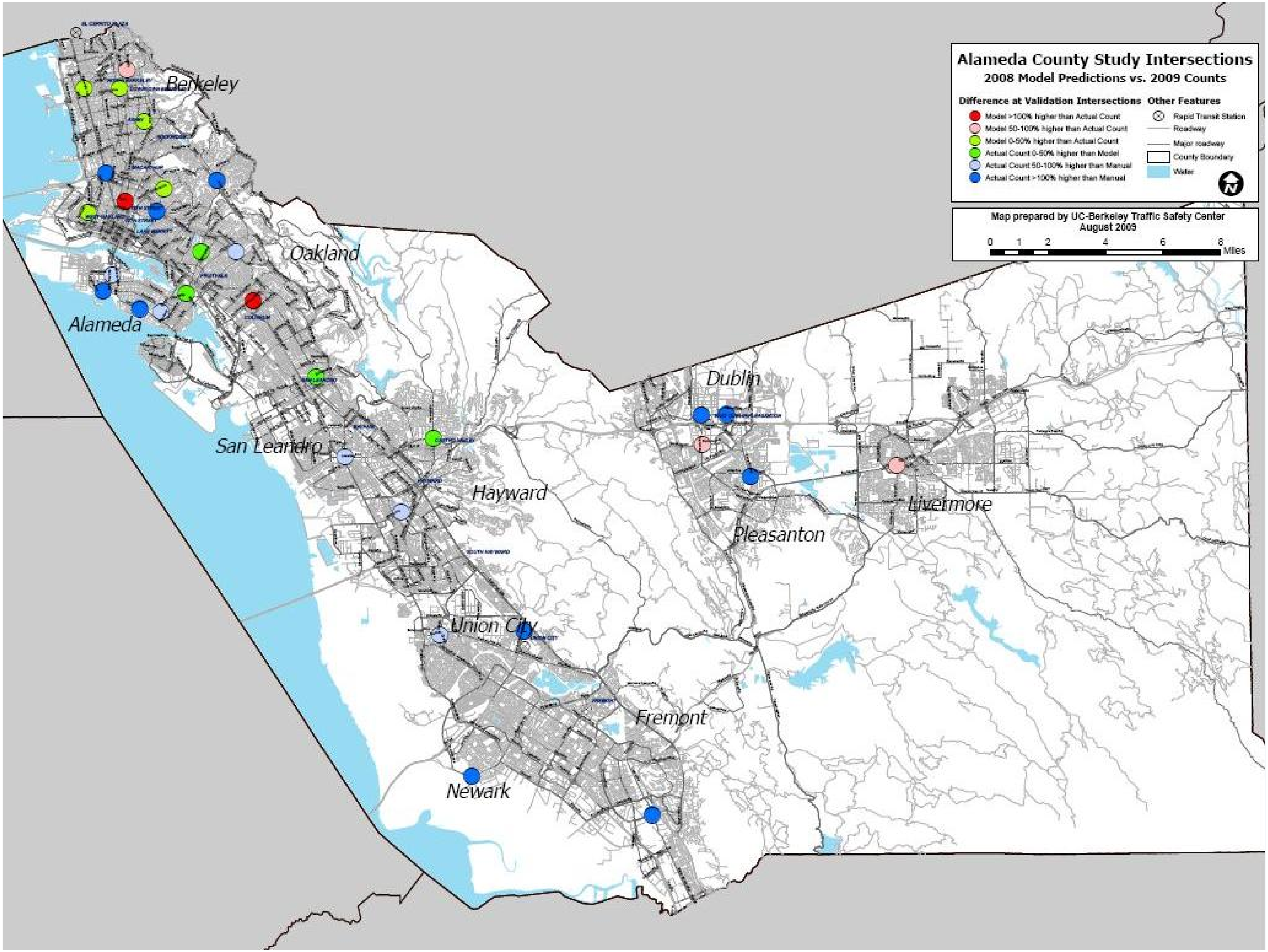
1) Percent difference is calculated using the smaller number as the base value. If the model value is greater than the actual value, the percent difference is calculated as (2009 - 2008)/2008. If the actual value is greater than the model value, the percent difference is calculated as (2008 - 2009)/2009.

Variation in "Typical" Alameda County Pedestrian Activity Pattern



Variation in Pedestrian Volumes

- Time of day, weather, etc. (accounted for)
- Measurement error
- “Unexplainable” variation
  - Individual sickness, people walking for scenery, store sales, etc.
  - Not feasible to predict in a planning-level model
  - Require additional data and cost for small benefit


Alameda County Study Intersections
2008 Model Predictions vs. 2009 Counts
Difference at Validation Intersections
Model >100% higher than Actual Count
Model 50-100% higher than Actual Count
Model 0-50% higher than Actual Count
Actual Count 0-50% higher than Model
Actual Count 50-100% higher than Manual
Actual Count >100% higher than Manual
Other Features
Rapid Transit Station
Roadway
Major roadway
County Boundary
Water
Map prepared by UC-Berkeley Traffic Safety Center
August 2009
0 1 2 4 6 8 Miles
Berkeley
Oakland
Alameda
San Leandro
Hayward
Union City
Fremont
Newark
Dublin
Pleasanton
Livermore

Alameda County Revised Model

Estimated Weekly Pedestrian Crossings =

	0.987	*	Total population within 0.5-miles of the intersection
+	2.19	*	Total employment within 0.25-miles of the intersection
+	71.1	*	Number of commercial properties within 0.25-miles of the intersection
+	49,300	*	Number of regional transit stations within 0.10-miles of the intersection
-	4850		(Constant)

Adjusted R^2 = 0.900

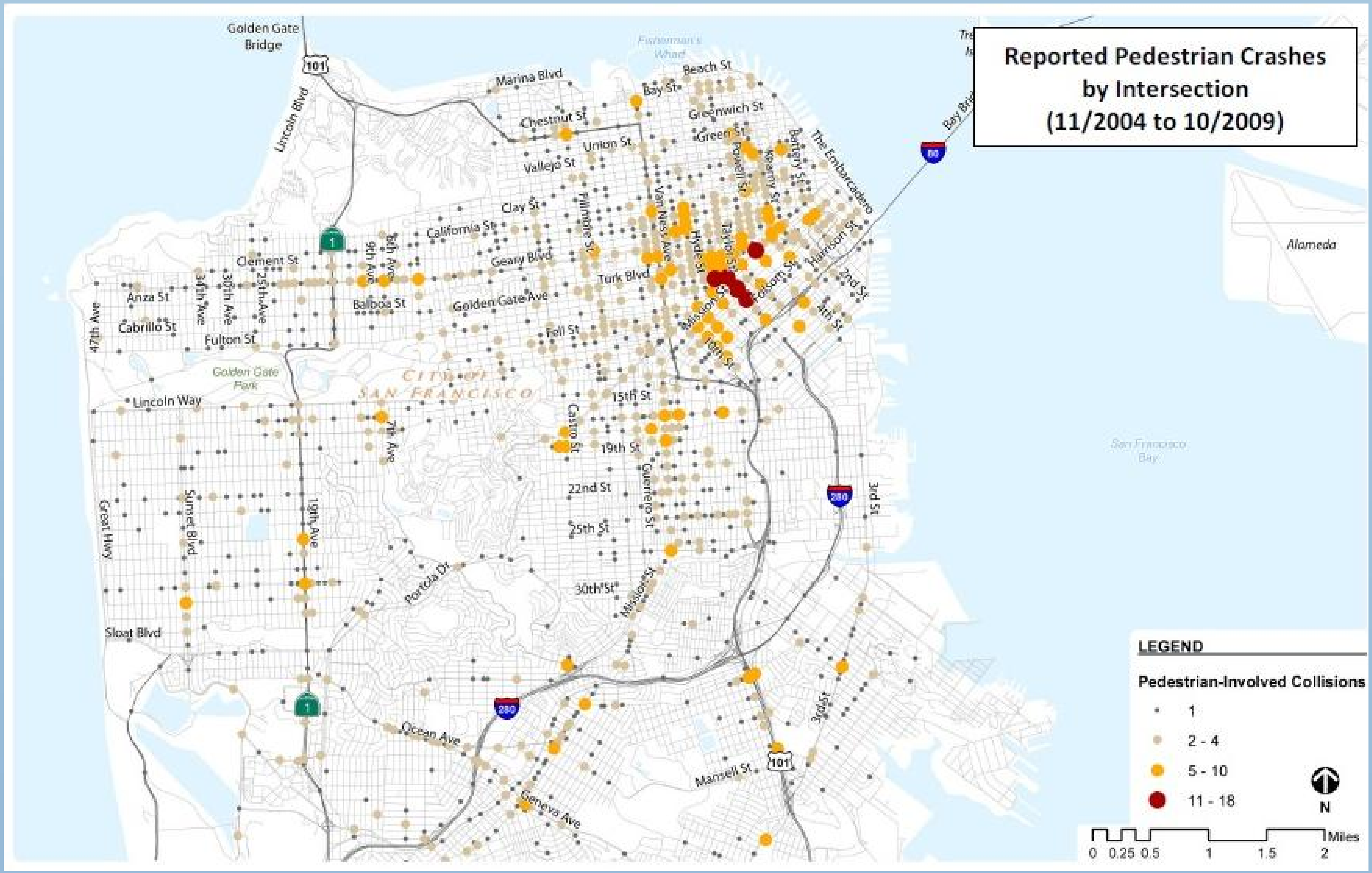
Root Mean Squared Error = 5310

Explanatory variables significant at 93% confidence interval

Key Consideration for Applying Existing Pedestrian & Bicycle Volume Models

- Designed for estimating volumes at neighborhood, corridor, and community levels. Actual pedestrian counts should be used for site-level safety, design, and engineering analyses.

Application for Pedestrian Safety Analysis: San Francisco Pedestrian Volume Model



Schneider, R.J., et al. “Development and Application of the San Francisco Pedestrian Intersection Volume Model” (2012). Map prepared by Fehr & Peers Transportation Consultants

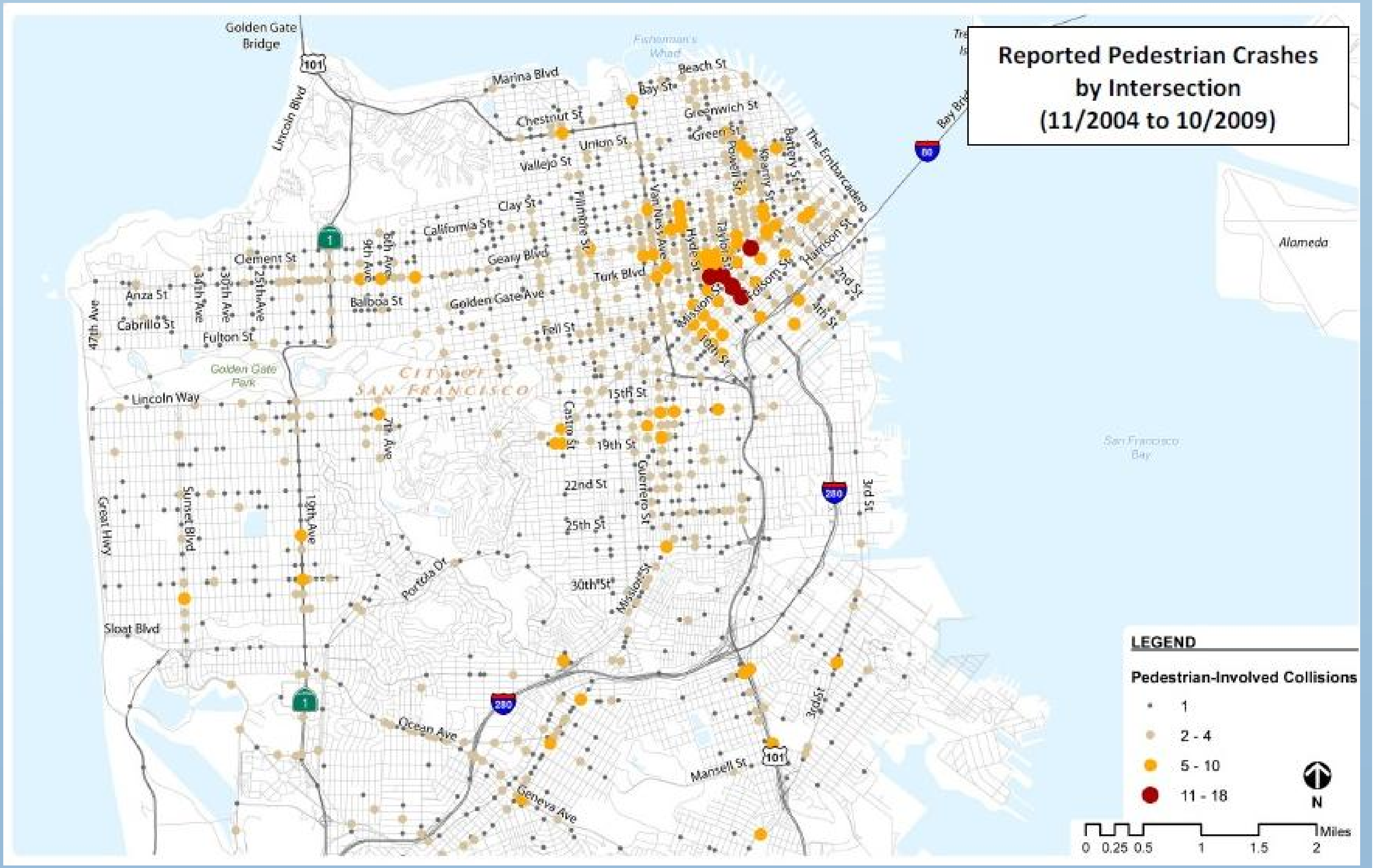
San Francisco Pedestrian Volume Model

Dependent Variable = Natural Logarithm of Total Annual Pedestrian Intersection Crossings[1]			
	Recommended Model		
Model Variables[2]	**Coefficient**	**t-value**	**p-value**
Total households within 1/4 mile (10,000s)	1.81	2.12	0.040
Total employment within 1/4 mile (100,000s)	2.43	2.22	0.032
Intersection is in a high-activity zone	1.27	3.79	0.000
Maximum slope on any intersection approach leg (100s)	-9.40	-3.07	0.004
Intersection is within 1/4 mile of a university campus	0.635	1.45	0.154
Intersection is controlled by a traffic signal	1.16	4.03	0.000
Constant	12.9	33.29	0.000
Overall Model			
Sample Size (N)	50		
Adjusted R^2-Value	0.804		
F-Value (Test value)	34.4 ($p < 0.001$)		

1) The dependent variable is the natural logarithm of the annual pedestrian intersection crossing volume at each of the 50 study intersections. This represents the sum of all crossings on each approach leg within 50 feet of intersection. The annual volume estimate is extrapolated from a two-hour manual count taken in September 2009 or July-August 2010. The extrapolation method accounts for variations in pedestrian activity by time of day, day of week, weather, and land use.
2) All distances used to calculate the model variables are straight-line distances rather than roadway network distances.

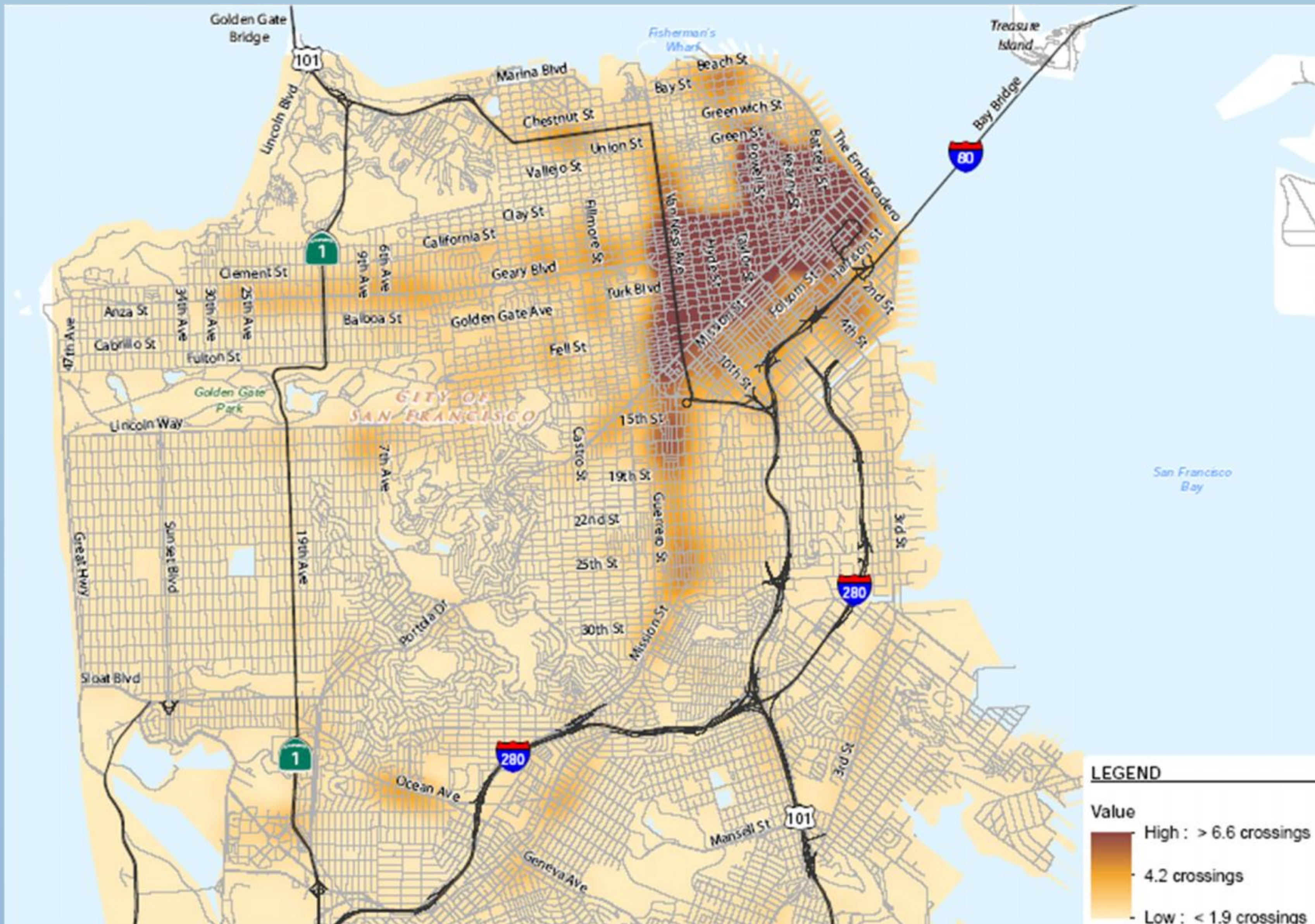
Schneider, R.J., et al. “Development and Application of the San Francisco Pedestrian Intersection Volume Model” (2012)

Reported pedestrian crashes



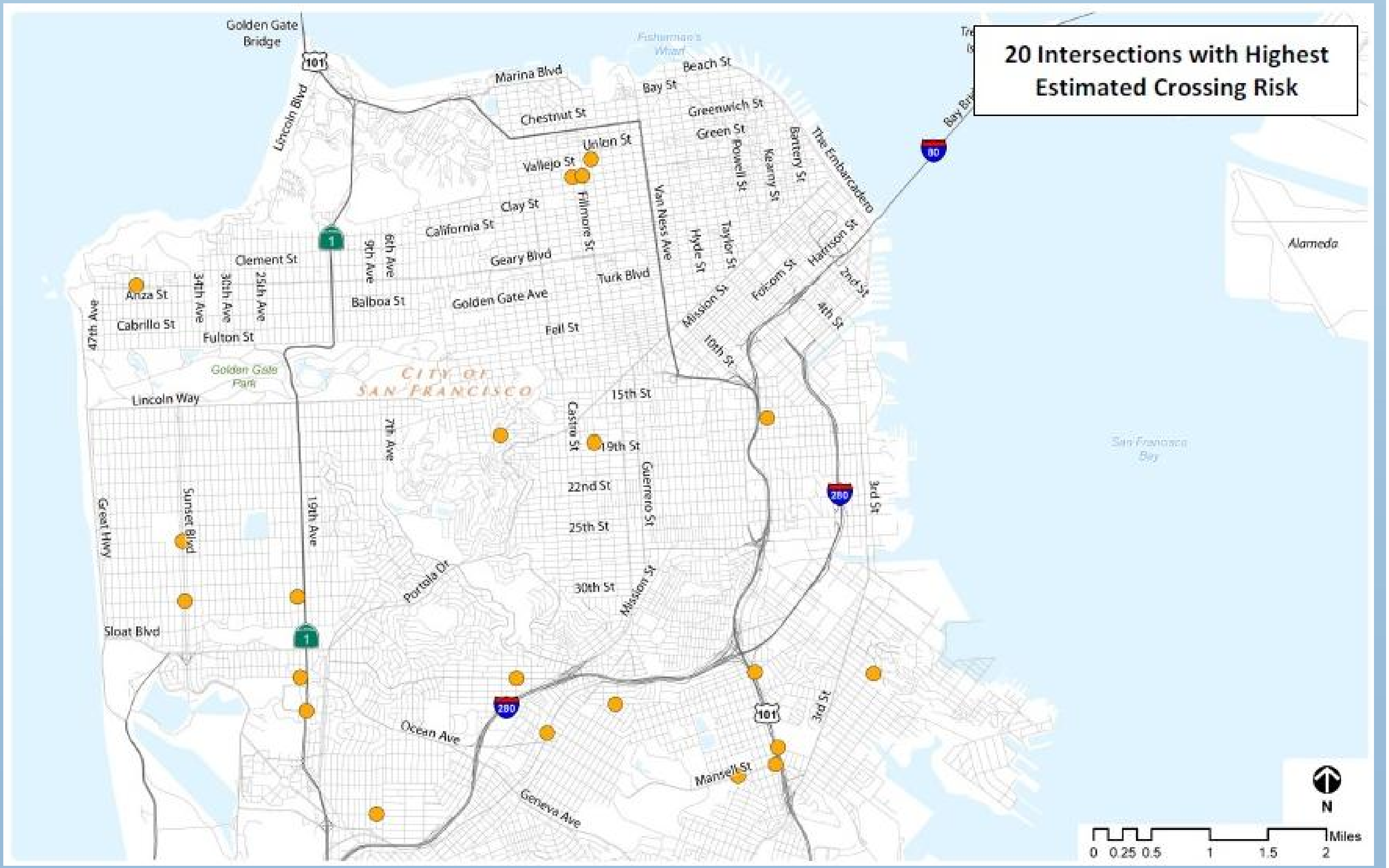
Schneider, R.J., et al. “Development and Application of the San Francisco Pedestrian Intersection Volume Model” (2012). Map prepared by Fehr & Peers Transportation Consultants

Model-estimated pedestrian crossings



Schneider, R.J., et al. “Development and Application of the San Francisco Pedestrian Intersection Volume Model” (2012). Map prepared by Fehr & Peers Transportation Consultants

Highest Estimated Pedestrian Crash Risk



Schneider, R.J., et al. “Development and Application of the San Francisco Pedestrian Intersection Volume Model” (2012). Map prepared by Fehr & Peers Transportation Consultants

General Characteristics of Intersections with Highest Pedestrian Risk in SF

- Most were unsignalized intersections.
- Many were along multilane arterial roadways.
- Several were located near schools.
- Several were in areas with steep slopes.

Bicycle Intersection Volume Models

San Diego County Bicycle Volume Model

PM Peak Hour Intersection Volume =

BAM = -4.279 + 0.718 * C + 0.438 * ED

Where:

BAM = Morning peak bicycle count

C = Footage of Class I bicycle path within a quarter-mile

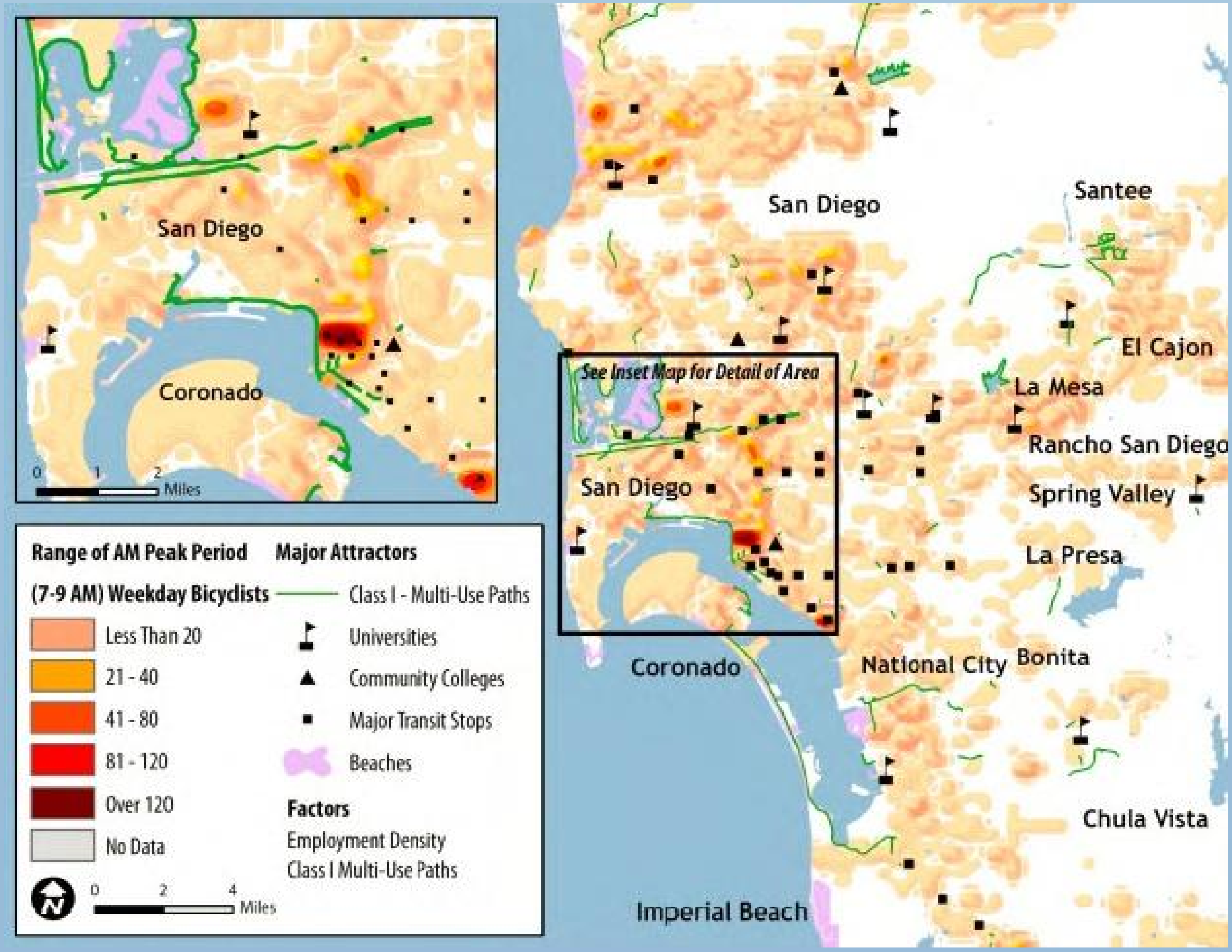
ED = Employment density within a quarter-mile

R^2 = 0.474

Explanatory variables significant at 95% confidence interval

Source: Jones, M.G., S. Ryan, J. Donlan, L. Ledbetter, L. Arnold, and D. Ragland. Seamless Travel: Measuring Bicycle and Pedestrian Activity in San Diego County and its Relationship to Land Use, Transportation, Safety, and Facility Type, Prepared by Alta Planning & Design and UC Berkeley SafeTREC, California Department of Transportation Task Order 6117, 2010.

San Diego County Bicycle Volume Model



Source: Jones, M.G. et al. Seamless Travel: Measuring Bicycle and Pedestrian Activity in San Diego County and its Relationship to Land Use, Transportation, Safety, and Facility Type, 2010.

Santa Monica Bicycle Volume Model

PM Peak Hour Bicycle Intersection Volume =

+ 10.97	* Land Use Mix
+ 0.342	* PM Bus Frequency
– 5.809×10^{-3}	* Population Density Under Age 18
+ 5.581	* Bike Network Score
+ 14.89	(Constant)

$R^2 = 0.471$

Explanatory variables significant at 95% confidence interval

Haynes, M. and S. Andrzejewski. “Santa Monica Bicycle & Pedestrian Demand Analysis,” Presentation by Fehr & Peers Transportation Consultants, April 20, 2010

Alameda County Bicycle Volume Models

Table 4. Alternative Bicycle Model Specifications

Model Variable	Model A: All Counts		Model B: Weekday		Model C: Weekend		Model D: Weekday Alt.	
	Coeff.	St. Err.	Coeff.	St. Err.	Coeff.	St. Err.	Coeff.	St. Err.
Dependent Variable = 2-hr Intersection Bicycle Count								
Constant	3.776	0.185***	3.899	0.262***	3.652	0.255***	-1.127	0.855
NComPropT	0.024	0.007***	0.030	0.010***	0.017	0.010*		
BikeSym	0.477	0.163***	0.437	0.230*	0.517	0.225***	0.459	0.269*
lnUCBDist	-0.458	0.059***	-0.546	0.083***	-0.369	0.081***		
SlopeH	-0.517	0.073***	-0.659	0.103***	-0.375	0.100***	-0.470	0.117***
CNRH							4.634	0.989***
Count09	0.811	0.127***	1.002	0.180***	0.620	0.176***	1.036	0.211***
Overall Model								
Sample size (*N*)	162		81		81		81	
Adjusted R^2	0.505		0.600		0.386		0.450	
F-test	33.87***		24***		11.08***		17.38***	

NOTE: Coeff. = coefficient and Std. Err. = standard error. *** = significant at 99% ($p < .01$); ** = significant at 95% ($p < .05$); * = significant at 90% ($p < .10$). Model variables are defined in Table 3.

Source: Griswold, J.B., A. Medury, and R.J. Schneider. “Pilot Models for Estimating Bicycle Intersection Volumes,” Transportation Research Record, Transportation Research Board, 2011.

Alameda County Bicycle Volume Models

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Count09	0.811	0.127***	1.002	0.180***	0.620	0.176***	1.036	0.211***
Overall Model								
Sample size (*N*)	162							
Adjusted R^2	0.505							
F-test	33.87***							

NOTE: Coeff. = coefficient and Std. Err. = standard … 05);
* = significant at 90% (p < .10). Model variables are …

- Commercial properties within 0.1 miles
- Bicycle facility on intersection approach
- **Distance to UC Berkeley**
- **Slope**
- Roadway network connectivity

Source: Griswold, J.B., A. Medury, and R.J. Schneider. "Pilot Models for Estimating Bicycle Intersection Volumes," Transportation Research Record, Transportation Research Board, 2011.

Common Bicycle Volume Model Variables

- Presence of bicycle facilities (e.g., multi-use trails, bicycle lanes)
- Employment or population density
- Proximity to commercial areas

Future Research

Conclusions

- Volume model uses: Planning, general risk analysis
- Location-based models have been developed recently
  - Simple regression equations with spreadsheet applications
  - Other methods are being explored (Portland, NCHRP, others)
- Community-specific models (No universal model yet)
- Planning-level accuracy
- Pedestrian models more common than bicycle

Questions & Discussion

UC Berkeley Safe Transportation Research & Education Center (SafeTREC)

www.safetrec.berkeley.edu

Thank You!

- **Archive at** http://www.walkinginfo.org/webinars
  - Downloadable and streaming recording, transcript, presentation slides
- **Questions?**
  - E-mail **David Ragland** at **davidr@berkeley.edu**
  - E-mail **John Bigham** at **jbigham@berkeley.edu**
  - E-mail **Robert Schneider** at **rjschneider@berkeley.edu**