FINAL REPORT
California Smart-Growth Trip Generation Rates Study
University of California, Davis for the California Department of Transportation
March 2013

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FUNDING
This project was funded by the California Department of Transportation (Caltrans) with Federal Highway Administration (FHWA) State Planning & Research Program (SPR) and State Public Transportation Account (PTA) funds provided by the Caltrans Headquarters Divisions of Transportation Planning, and Research & Innovation. Ms. Terry Parker, Senior Planner in the Transportation Planning Division's Office of Community Planning, provided overall coordination of this project and Final Report preparation.

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Final Report for the California Smart-Growth Trip Generation Rates Study

1. Introduction

The California Environmental Quality Act (CEQA) and other state, federal, and local laws require the identification, analysis, and mitigation of transportation-related impacts of proposed land use projects. The first step in preparing a transportation impact analysis is to estimate the number of trips by cars, trucks, and other modes of travel that may result from a proposed land use project – a process commonly referred to as "trip-generation." Currently, practitioners typically use trip-generation rates published by the Institute of Transportation Engineers (ITE), a national professional organization.

For the most part, ITE's trip-generation rates are based on data obtained at suburban locations that lack good transit or bicycle and pedestrian facilities. Not surprisingly, studies indicate that these rates often significantly over-estimate the number of trips from cars and trucks for land use projects located in urban areas near transit and within easy walking distance of other land uses (Tindale Oliver and Associates 1993; Steiner 1998; Muldoon and Bloomberg 2008; Arrington and Cervero 2008; Kimley Horn Associates 2009; Bochner *et al*. 2011). In fact, ITE guidelines state that their trip-generation rates data should not be used for such projects, here labeled "smart growth" projects.

However, there is currently no commonly accepted methodology in the U.S. for estimating multi-modal trip-generation rates associated with smart-growth projects. This makes it very difficult for practitioners to accurately estimate the traffic impacts of such projects, or to identify and recommend appropriate or adequate transportation "mitigations," including walking, biking, and transit facilities. By following existing guidelines, transportation engineers often over-prescribe automobile infrastructure in smart-growth locations, resulting in wider roadways, more turning lanes, and more parking spaces than necessary. In addition, there is no established approach to recommend adequate pedestrian, bicycle, or public transit facilities that may improve conditions for traveling by these other modes.

The goal of this project was to develop a methodology and spreadsheet tool that practitioners can use to estimate multi-modal trip-generation rates for proposed smart-growth land use development projects in California. The project involved multiple tasks (Table 1), carried out between September 2009 and February 2013. The UC Davis Project Team (Table 2) collected trip-generation data at 30 smart growth sites in California and used this information, along with trip generation data from other studies, to develop a method built into a spreadsheet tool that adjusts trip-generation estimated based on ITE rates. The technical advisory panel for the project, called the "Practitioners Panel," provided important input throughout the project. The Panel comprised representatives from state, regional, and local agencies as well as private consulting firms and non-governmental organizations (Table 3).

This report describes three key steps in the process of developing the tool: the identification and evaluation of existing tools, the development and implementation of a data collection methodology, and the development of the trip generation method. Appendices A-F present the detailed results of the project (Table 4). This report and the appendices are available at: http://ultrans.its.ucdavis.edu/projects/smart-growth-trip-generation.

Table 1. Project Tasks

Task	Description	Appendix
1	Operating procedures and acceptance criteria	-
2	Definitions: define key terms required for this effort	A
3	Identification, review, summary and evaluation of available information	B
4	Practitioners Panel	-
5	Design door count procedures	E
6	Evaluate existing analysis methodologies	C, D
7	Select or modify existing methodology, or develop a new methodology	F
8	Draft and Final Summary Reports of the Entire Study	-
9	Design Data Collection Procedures and Intercept Survey	E
10	Site selection	E
11	Pilot count and summary	E
12	Cordon count collection and summary	E
13	Cordon count analysis and report	E

Table 2. Project Team

Terry Parker, M.A., Caltrans Project Manager Dr. Susan Handy, Principal Investigator Dr. Kevan Shafizadeh Dr. Robert Schneider Dr. Richard K. Lee Dr. Deborah Niemeier Dr. Brian Bochner, Texas Transportation Institute Dr. Benjamin Sperry, Texas Transportation Institute	Rachel Maiss, graduate student Josh Miller, graduate student David van Herick, graduate student Nanako Tenjin, graduate student Calvin Thigpen, graduate student Mary Madison Campbell, project assistant

Table 3. Practitioner Panel Members

Organization	Representative
State & Regional Agencies	
Caltrans – (Calif. Dept. of Transportation)	Marc Birnbaum, Supervising Senior Transportation Planner (HQ Traffic Operations Division)
Metropolitan Planning Organization	
San Diego Association of Governments (SANDAG)	Christine Eary, Associate Regional Planner

Local Government	
City of San Diego – Planning Department	Samir Hajjiri, Senior Traffic Engineer (PE)
Non-profit organizations	
TransForm (SF Bay Area)	Ann Cheng, Senior Planner, GreenTRIP manager Jennifer West, GreenTRIP Program Associate
Consultants, etc.	
Economic & Planning Systems (EPS)	Ed Sullivan, GIS Senior Technical Associate
Gibson Transportation Consulting	Pat Gibson, President (PTOE)
Pang Ho PHA Associates	Pang Ho, Principal, PH Associates (PE)
Parsons Brinckerhoff (PB)	Donald Hubbard, Senior Supervising Planner
Townworks + DPZ	Paul Crabtree, Principal (PE)
TPG Inc.	Charles Clouse, Principal (AICP, PCP)
VRPA Technologies, Inc.	Erik Ruehr, Director of Traffic Engineering (PE)

Table 4. Appendices to the Final Report

Appendix A. Definition of "smart growth"
Appendix B. Annotated review of land use & transportation literature
Appendix C. Summary & comparison of existing tools worldwide
Appendix D. Evaluation of the operation & accuracy of available methodologies
Appendix E. UCD's Data Collection Methodology and Results
Appendix F. Method for Adjusting ITE Trip Generation Estimates for Smart Growth Projects
Smart Growth Trip-Generation Adjustment Tool

2. Existing Tools

The UC Davis Project Team searched for existing tools that provide trip generation estimates for smart growth projects (as described in Appendices C and D). A key consideration was the tool's ability to respond to location, density, mixed land uses, and other design characteristics that have been found to facilitate non-motorized travel and thereby reduce vehicle trips. In general, the search emphasized tools that are more context-sensitive than the traditional ITE *Trip Generation* method.

The Team identified eight existing tools. A majority of the identified tools adjust the ITE trip generation rates (or an alternative set of rates compiled by the San Diego Association of Governments (SANDAG)) to better reflect the effects of location, density, mixed land uses, and other design characteristics on trip generation. In addition to this type of tool, the team identified two other types: tools that provide rates based on trip generation data collected at sites with smart growth characteristics, and one tool that uses person-trip data from a travel survey. All of these tools showed the potential to be better than the traditional ITE *Trip Generation* method, though none was without obvious limitations.

Table 5. Existing Tools Identified and Assessed

Tool	Included in Assessment?
Adjustments to ITE/SANDAG Rates	
ITE Mixed-Use	Yes
EPA Mixed-Use Model/SANDAG Mixed-Use Model	Yes
URBEMIS	Yes
NCHRP 8-51 Method and Spreadsheet Tool	Yes
Eakland's Model	No – San Diego only
Organized Empirical Database Tools	
UK's TRICS	No – UK data only
New Zealand Trips and Parking Database	No – NZ data only
Person-Trip Based Tools	
San Francisco Method/MTC Survey Method	Yes

The Team undertook an evaluation of five of these tools. The evaluation consisted of two parts:

1. An assessment of their operational characteristics, based on criteria identified by an expanded Practitioners Panel;
2. An analysis of the accuracy of each tool in estimating trip generation for 22 sites in California for which observed trip counts were available.

Operational Criteria

An expanded Practitioners Panel that included 20 representatives from various local and regional agencies, non-profit groups, and consulting firms identified key operational criteria by which the tools were assessed. During several conference calls, the panelists discussed the qualities – in addition to accuracy – that they most require in a tool for estimating trip generation for smart growth land use projects. From these discussions, the Team compiled a list of operational criteria and reviewed them with the panelists. The operational criteria were grouped into the following categories: 1) Ease of use; 2) Sensitivity to key smart growth elements; 3) Input requirements; 4) Output features; and 5) Usability of a methodology or tool in helping to define smart growth projects based on their performance.

Based on its experience in applying each method (to analyze their accuracy, as described below), the Team rated the methods/tools on each criterion. The Team then invited panelists to rate the criteria as to their relative importance via an on-line survey. Eight members of the Practitioners Panel responded to the on-line survey. Respondents were asked to rate each criterion from one to six with one being “least important” and six being “most important.” The eleven top-rated criteria are shown in Table 6. The Team then assessed tools based on the combination of the performance rating and the importance rating. This assessment showed that no one tool met every operational goal, and thus none emerged as a clear “winner.”

Table 6. Most Important Operational Criteria

Criterion	**Criterion Type**	**Rating (on 6 point scale)**
Sensitivity of outputs to inputs	Input requirements	6.0
Results replicable by other analysts	Output	5.8
Results should not fluctuate excessively	Additional criteria	5.6
Method measures the performance of different kinds of land use policies	Additional criteria	5.6
AM/PM/daily/other time frames reported	Output	5.4
Auto vs. other trip generation rates	Output	5.3
LU context variables	Sensitivity	5.1
Internal capture shown	Output	5.0
Project-level variables	Sensitivity	5.0
Transport variables	Sensitivity	4.9
Project description by land use(s) and size	Output	4.9

Accuracy

The Practitioners Panel identified the ability to accurately predict trip generation for projects as the most important criterion against which each method or tool should be evaluated. To assess the relative accuracy of each of the five candidate methods, the Team compared available cordon counts at ten multi-use sites and twelve infill sites in California against estimates from the five candidate methodologies (see Appendix D). These methods were also compared to the industry standard ITE trip generation rates for single land uses.

Traffic count data used to evaluate the accuracy of the candidate methodologies come from two sources: 1) daily and peak-hour traffic counts at 10 sites in California originally collected for validation of the EPA/SANDAG mixed-use method (referred to as the “multi-use sites”); and 2) peak hours cordon count and intercept survey data for 12 infill sites that was gathered for Caltrans' *Trip-Generation Rates for Urban Infill Land Uses in California* study (referred to as the "infill sites"). Most of the multi-use sites are medium to large-scale developments (5 to 200+ acres) located outside urban cores. By contrast, the Infill sites are single uses located in urban cores close to high-quality transit. Appendix D provides information about each of the sites.

The results of the accuracy analysis also did not identify a clear "winner." For the multi-use sites, the EPA mixed-use method produced the most accurate estimate for the greatest number of sites, particularly for daily counts. This was not surprising, given that these sites were chosen based on their similarity to the sites used to calibrate the method. For the sites for which the EPA method was not most accurate, no one method proved best: the other four methods were each most accurate for at least two site-time period combinations. For the single-use urban infill sites, a clearly best method did not emerge, with each method proving most accurate for some number of site-time period combinations. However, the results showed that all of the methods performed better than the ITE rates for both multi-use and infill sites.

Given the limitations of the available tools for estimating trip generation at smart growth sites with respect to both operational characteristics and accuracy, the Project Team under the guidance of the Practitioners Panel proceeded to pursue the development of an entirely new method based on the data used in accuracy assessment as well as additional data collected at smart growth sites in California as a part of this project.

3. Data Collection

The UC Davis Project Team, with input from a subcommittee of the Practitioners Panel, next developed a data collection and analysis methodology to document the number of pedestrian, bicycle, public transit, and automobile trips generated by developments in smart-growth areas in California (as described in detail in Appendix E). The methodology builds upon established methods so that it can be integrated easily into standard transportation engineering and planning practice. It can be replicated and refined in other communities seeking to collect trip generation data in smart-growth areas.

The Team applied the methodology in the field at 30 study locations in California during spring 2012. Study locations consisted of a single land use within a smart growth development site; detailed descriptions of the sites and the criteria by which they were selected are provided in Appendix E. Field data collection involved a combination of door counts and intercept surveys. The core component at each study location was a count of all people entering and exiting the site or targeted land use. In-person intercept surveys were administered to a sample of people as they exited doors at each study location. These surveys were designed to determine 1) the mode, time of day, origin, and length of inbound trips to the study location and 2) the mode, time of day, destination, and length of outbound trips from the study location. The intercept surveys also collected information about vehicle occupancy so that the person-trip counts for automobile users could be compared to ITE vehicle-based trip rates.

Overall, the door counters recorded a total of 31,515 individual entries and exits at the 30 locations. The surveyors approached a total of 5,501 people and of these, 3,371 (61%) provided at least a basic response with their current travel mode (2,129 refused to participate and one did not provide a travel mode). The 3,371 respondents reported a total of 5,170 trips. Based on these data, the Team calculated peak-hour person trips by mode for each location and compared peak-hour vehicle trips to estimates of such trips based on ITE rates. The analysis showed that automobile person-trips accounted for fewer than half of morning peak-hour trips at 10 study locations and fewer than half of afternoon peak-hour trips at 11 study locations. As a result, the numbers of vehicle trips at these smart growth sites were, on average, approximately half as high as predicted by standard ITE trip generation rates.

This data collection methodology has several advantages over existing approaches that use automated technologies to count automobiles entering and exiting access points to developments. These advantages are particularly important in urban areas with mixed-use developments, mixed-use buildings, and a variety of parking arrangements. Existing methods that only capture automobile trips would have missed more than half of all person-trips recorded at the study locations: overall, 27% of person-trips were made by walking, 21% by transit, and 3% by bicycle.

4. Trip Generation Method

Although vehicle trips at the 30 California smart growth locations for which UC Davis collected data were, on average, much lower than ITE rates would predict, the difference between actual and ITE-estimated vehicle trips varied from site to site (Table 7). In order to provide the best possible estimates of vehicle trips at new development sites in smart-growth areas, it is necessary to account for this variation. To this end, the UC Davis Project Team developed a method that can be used by practitioners to adjust estimates based on existing ITE rates to produce more accurate weekday AM and PM peak hour vehicle trip generation rate estimates at developments with smart-growth characteristics.

The method takes estimates of vehicle trips based on ITE rates and adjusts them based on characteristics of the proposed development project and its surrounding context (as described in detail in Appendix F). At the core of the method are simple linear regression equations with the AM or PM adjustment factor as the dependent variable and easily-measured site and context characteristics as the explanatory variables. These AM and PM models were developed using a database of vehicle trip counts and site/context data for a sample of 50 "smart-growth" sites in California. This sample was drawn from the 30 locations for which UC Davis collected data in Spring 2012, the 22 sites used in the assessment of existing tools (see Section 2, above), and sites from other studies; sites not used in developing the equations were reserved for validating the equations.

The starting point for the model development process was the extensive literature on the connections between characteristics of the built environment and travel behavior. Empirical evidence points to the importance of factors such as population density and land use mix as

Table 7. Actual Peak-hour Vehicle-Trips versus Estimated Vehicle-Trips from Published ITE Rates

	Targeted Land Uses (ITE Use Code)[1]				AM Peak Hour								PM Peak Hour							
Site Name	Mid- to High-Density Residential	Office	Commercial Retail Goods	Coffee/Donut Shop	Actual Total Person Trips[2]	Actual Auto Person Trips[3]	Actual Auto Occupancy[4]	Actual Vehicle Trips	ITE-Estimated Vehicle Trips[5]	Actual-ITE Vehicle Trips	ITE/Actual Vehicle Trips[6]	ITE-Estimated Total Person Trips[7]	Actual Total Person Trips[2]	Actual Auto Person Trips[3]	Actual Auto Occupancy[4]	Actual Vehicle Trips	ITE-Estimated Vehicle Trips[5]	Actual-ITE Vehicle Trips	ITE/Actual Vehicle Trips[6]	ITE-Estimated Total Person Trips[7]
Pegasus	222				136	42	1.18	**36**	**92**	-56	2.56	109								
Sakura Crossing	223				106	85	1.10	**77**	**66**	11	0.86	73	152	68	1.10	**61**	**86**	-25	1.40	95
Argenta	222				89	33	1.34	**25**	**53**	-28	2.14	71	107	29	1.34	**22**	**62**	-40	2.85	83
Fremont Building	223				50	31	1.23	**25**	**20**	5	0.80	25	42	28	1.23	**23**	**26**	-3	1.13	32
Artisan on 2nd	223				62	41	1.28	**32**	**34**	-2	1.06	44	51	40	1.28	**31**	**44**	-13	1.41	56
Terraces Apartment Homes[8]	223				88	69	1.29	**54**	**78**	-24	1.45	101	85	47	1.29	**37**	**101**	-64	2.76	130
Holly Street Village[9]	223				175	144	1.33	**108**	**107**	1	0.99	142	185	125	1.33	**94**	**139**	-45	1.48	185
Broadway Grand	223				72	36	1.57	**23**	**32**	-9	1.42	50	85	34	1.57	**22**	**42**	-20	1.93	66
Archstone at Del Mar Station	223				98	66	1.31	**50**	**66**	-16	1.32	86	102	60	1.31	**46**	**86**	-40	1.87	113
The Sierra	223				121	74	1.47	**50**	**66**	-16	1.31	97	166	90	1.47	**61**	**86**	-25	1.40	126
Terraces at Emery Station	223				159	112	1.12	**100**	**30**	70	0.30	34	138	98	1.12	**87**	**39**	48	0.45	44
Victor on Venice	223				61	51	1.17	**44**	**33**	11	0.76	39	76	59	1.17	**50**	**43**	7	0.85	50
343 Sansome[10]		710			316	103	1.43	**72**	**355**	-283	4.93	508	333	84	1.43	**58**	**341**	-283	5.83	488
Convention Plaza		710			514	214	1.17	**183**	**481**	-298	2.63	563	491	193	1.17	**165**	**462**	-297	2.80	541
Charles Schwab Building		710			510	104	1.77	**59**	**498**	-439	8.45	881	401	76	1.77	**43**	**479**	-436	11.17	848
Park Plaza		710											53	36	1.27	**28**	**95**	-67	3.36	121
Park Tower		710			617	383	1.20	**319**	**645**	-326	2.02	774	566	374	1.20	**312**	**620**	-308	1.99	744
Oakland City Center		710			248	128	1.28	**100**	**297**	-197	2.96	380	221	75	1.28	**59**	**286**	-227	4.88	366
180 Grand Avenue		710			184	96	1.21	**80**	**271**	-191	3.40	328	143	79	1.21	**65**	**261**	-196	4.02	316
Emery Station East		710			298	151	1.14	**133**	**365**	-232	2.75	416	251	140	1.14	**123**	**351**	-228	2.86	400
181 Second Avenue		710			101	101	1.10	**92**	**77**	15	0.84	85	114	94	1.10	**85**	**74**	11	0.87	81
Oakland City Center			880										479	0	1.28	**0**	**93**	-93	Undefined	119
Paseo Colorado			820										1551	1208	1.57	**770**	**1856**	-1086	2.41	2914
Fruitvale Station			867										116	99	1.50	**66**	**102**	-36	1.54	153
343 Sansome[10]				936	356	41	1.43	**29**	**129**	-100	4.45	184								
Convention Plaza				936	259	62	1.17	**53**	**182**	-129	3.46	213	80	25	1.17	**21**	**63**	-42	2.97	74
Park Tower				936	430	94	1.20	**78**	**194**	-116	2.48	233	90	23	1.20	**19**	**67**	-48	3.55	80
Oakland City Center[11]				936																
Broadway Grand				936	316	141	1.57	**90**	**152**	-62	1.69	239	237	57	1.57	**36**	**53**	-17	1.46	83
Fruitvale Station				936									192	179	1.50	**119**	**54**	65	0.45	81
					5365	2403		**1911**	**4323**	-2412	2.26	5673	6508	3419		**2504**	**6011**	-3507	2.40	8389

1) ITE Use Codes are from the ITE Trip Generation Manual, Eighth Edition.
2) Actual total person trips trips is the total number of person trips during the peak hour at the study location. The estimated number of trips was adjusted for gender bias and different mode shares at each door. Locations with fewer than 30 surveyed trips during a data collection period were not analyzed because they were determined to have insufficient data to estimate mode shares.
3) Actual automobile person trips is the total number of person trips that used an automobile mode at each site.
4) Automobile occupancy was estimated from the total morning or afternoon survey responses at each site.
5) ITE-estimated vehicle trips were calculated using standard Trip Generation Manual (2008) trip rates.
6) The ratio of ITE vehicle trips to actual vehicle trips is undefined when the estimate of actual peak hour vehicle trips was 0.
7) ITE-estimated total person trips were calculated by multiplying the ITE-estimated vehicle trips by the average automobile occupancy for each site. This assumes that the ITE estimates are based sites with 100% automobile mode share.
8) PM data collection at Terraces Apartment Homes was from 3:30 p.m. to 6:30 p.m.
9) PM data collection at Holly Street Village was from 3:30 p.m. to 6:30 p.m.
10) AM data collection at 343 Sansome was from 6:30 a.m. to 9:30 a.m.; PM data collection at 343 Sansome was from 4:00 p.m. to 6:30 p.m.
11) Results were not reported for the Oakland City Center coffee shop because there were fewer than 30 surveys in both the AM and PM study periods.

predictors of trip frequency and mode choice (see Appendix B). Guided by this evidence, the Team created a database of potential explanatory factors—variables that may predict the difference between actual trip counts at smart-growth development projects and trip estimates based on ITE rates. The Team focused on variables that would be relatively easy to measure or acquire using data from the U.S. Census, Google Maps, transit agencies, and other sources.

In order to create theoretically-sound models that are also practical to use, the Team tested many variables and many model structures. Because smart growth characteristics are commonly found together (e.g. it is unusual to find high population density without frequent transit service, and vice versa), many of the potential explanatory factors were statistically correlated, a problem in fitting linear regression equations. To address this problem, the Team settled on a two-stage approach, which was presented to and approved by the Practitioners Panel. In the first stage, a smart growth factor is calculated as a function of eight site and context characteristics (see Table 8). In the second stage, the calculated smart growth factor, a dummy variable for the particular land use, and a dummy variable for proximity to a university are plugged into a linear regression equation to estimate an adjustment factor (see Table 9). The equations, their derivation, and their application are discussed in detail in Appendix F.

Table 8. Variables in Smart Growth Factor Equation

Residential population within a 0.5-mile, straight-line radius (000s)
Jobs within a 0.5-mile, straight-line radius (000s)
Straight-line distance to center of major central business district (CBD) (miles)
Average building setback distance from sidewalk (feet)
Metered on-street parking within a 0.1-mile, straight-line radius (1=yes, 0=no)
Individual PM peak-hour bus line stops passing within a 0.25-mile, straight-line radius
Individual PM peak-hour train line stops passing within a 0.5-mile, straight-line radius
Proportion of site area covered by surface parking lots (0.00 to 1.00)

Table 9. Variables in Adjustment Factor Equation

Smart-Growth Factor
Office land use (1 = yes, 0 = no)
Coffee shop land use (1 = yes, 0 = no)
Multi-use development (1 = yes, 0 = no)
Within 1 mile of a university (1 = yes, 0 = no)
Office land use (1 = yes, 0 = no)

The AM and PM models were validated using the sites with available vehicle trips counts that were not used in developing the equations. Validation was done by comparing the ratio of actual to ITE-estimated vehicle trips from the models with the observed data at the validation sites. This comparison showed that the models predicted the smart-growth adjustment accurately at some validation sites (e.g. the model ratio was within 50% of the observed ratio) but lacked accuracy at other sites. In general, the models overestimated the ratio of actual to ITE vehicle trips at sites with the least accurate model predictions (i.e., actual trip data showed that sites had fewer vehicle trips than the model predicted). Thus, the models produced conservative adjustments relative to ITE-based trip estimates.

It is important to note that the resulting models are only appropriate for analysis at single-use sites or single land uses that are a part of multi-use sites and only for such sites that are in smart-growth areas. In consultation with the Practitioners Panel, the Team defined specific criteria that should be met in order to apply the model (Table 10). For sites that do not meet these criteria, the models may overestimate the adjustment to ITE rates and thus underestimate vehicle trips.

Table 10. Criteria for Applying Models

Land Uses	ITE Trip Generation Land Use Codes: Residential (220, 222, 223, 230, 232), office (710), restaurant (925, 931), and coffee/donut shop (936); potentially applicable to retail land use codes.
Development	▪ The area within a 0.5-mile radius of the site is mostly developed, and ▪ There is a mix of land uses within a 0.25-mile radius of the site, and ▪ J>4,000 and R>(6,900-0.1J), where J is the number of jobs within a 0.5-mile radius of the site and R is the number of residents within a 0.5-mile radius of the site, and ▪ There are no special attractors within a 0.25-mile radius of the site (e.g., stadiums, military bases, commercial airports, etc).
Transit service	During a typical weekday PM peak hour, there are at least 10 bus stop locations on all bus lines that pass within any part of a 0.25-mile radius around the study site, or 5 individual train stop locations on all train lines that pass within any part of a 0.5-mile radius around the study site during a typical weekday PM peak hour.
Pedestrian or bicycle infrastructure	There is at least one designated bicycle facility within two blocks of the edge of the site (designated bicycle facilities include multi-use trails, cycle tracks, and bicycle lanes), or there is >50% sidewalk coverage on streets within a 0.25-mile radius of the site.

The UC Davis Project Team developed a spreadsheet tool that practitioners can use to apply the method. The first page of the spreadsheet outlines the criteria for applying the method. The practitioner enters data for the development project for each of the criteria. If the development project meets the criteria, the practitioner can then move to the second page, where he or she enters additional data needed by the models, and the spreadsheet then calculates the adjustment factors and trip generation estimates. The Practitioners Panel reviewed draft versions of the spreadsheet tool and made many useful suggestions to improve its usability. The spreadsheet tool is available at:

http://downloads.ice.ucdavis.edu/ultrans/smartgrowthtripgen/CA_SGTG_Spreadsheet_Tool_1.0.xlsx

5. Conclusions

This project addressed the need for a methodology that practitioners can use to estimate multi-modal trip-generation rates for proposed smart-growth land use development projects in California. After identifying and assessing existing alternatives to ITE trip generation rates, the UC Davis Project Team concluded that a new method, based on new data, was needed. The Team collected multi-model trip-generation data at 30 locations in California and used these data, along with available data from other studies, to develop a smart-growth trip-generation tool.

This tool represents a significant step forward, but additional work is needed. It is likely that the small-sample models do not account for all of the complex variation in sites, including different levels of economic activity at particular locations. Additional data collection is needed at a wider range of land uses and at sites with a wider range of characteristics. Given enough data, it may be possible to develop separate models for different land use categories to account for the specific ways that smart growth characteristics affect trip generation for those uses. In addition, given enough data, it may be possible to develop models that estimate trips directly as a function of site characteristics rather than as an adjustment to ITE-based estimates. Ultimately, the results of this and future studies will benefit practitioners seeking to evaluate developments that support sustainable transportation and land use systems.

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