



Trip Generation Manual

10th Edition • Volume 1: Desk Reference

SEPTEMBER 2017



Trip Generation Manual

10th Edition • Volume 1: Desk Reference



INSTITUTE OF TRANSPORTATION ENGINEERS

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Institute of Transportation Engineers
1627 Eye Street, NW, Suite 600
Washington, DC 20006 USA
Phone: +1 202-785-0060
E-mail: ite_staff@ite.org

Trip Generation Manual, 10th Edition

Volume 1: Desk Reference

The Institute of Transportation Engineers is an international educational and scientific association of transportation professionals who are responsible for meeting mobility and safety needs. ITE facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development, and management for any mode of ground transportation. Through its products and services, ITE promotes professional development of its members, supports and encourages education, stimulates research, develops public awareness programs, and serves as a conduit for the exchange of professional information.

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Institute of Transportation Engineers
1627 Eye Street, NW, Suite 600
Washington, DC 20006 USA
Telephone: 202-785-0060
Fax: 202-785-0609
www.ite.org

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Land Use Codes

Port and Terminal (Land Uses 000–099)

CODE LAND USE

021	Commercial Airport
022	General Aviation Airport
030	Intermodal Truck Terminal
090	Park-and-Ride Lot with Bus or Light Rail Service

Industrial (Land Uses 100–199)

CODE LAND USE

110	General Light Industrial
130	Industrial Park
140	Manufacturing
150	Warehousing
151	Mini-Warehouse
154	High-Cube Transload and Short-Term Storage Warehouse
155	High-Cube Fulfillment Center Warehouse
156	High-Cube Parcel Hub Warehouse
157	High-Cube Cold Storage Warehouse
160	Data Center
170	Utility
180	Specialty Trade Contractor

Residential (Land Uses 200–299)

CODE LAND USE

210	Single-Family Detached Housing
220	Multifamily Housing (Low-Rise)
221	Multifamily Housing (Mid-Rise)
222	Multifamily Housing (High-Rise)
225	Off-Campus Student Apartment
231	Mid-Rise Residential with 1st-Floor Commercial

232	High-Rise Residential with 1st-Floor Commercial
240	Mobile Home Park
251	Senior Adult Housing—Detached
252	Senior Adult Housing—Attached
253	Congregate Care Facility
254	Assisted Living
255	Continuing Care Retirement Community
260	Recreational Homes
265	Timeshare
270	Residential Planned Unit Development

Lodging (Land Uses 300–399)

CODE LAND USE

310	Hotel
311	All Suites Hotel
312	Business Hotel
320	Motel
330	Resort Hotel

Recreational (Land Uses 400–499)

CODE LAND USE

411	Public Park
416	Campground/Recreational Vehicle Park
420	Marina
430	Golf Course
431	Miniature Golf Course
432	Golf Driving Range
433	Batting Cages
434	Rock Climbing Gym
435	Multipurpose Recreational Facility
436	Trampoline Park
437	Bowling Alley
440	Adult Cabaret

444	Movie Theater
445	Multiplex Movie Theater
452	Horse Racetrack
453	Automobile Racetrack
454	Dog Racetrack
460	Arena
462	Professional Baseball Stadium
465	Ice Skating Rink
466	Snow Ski Area
470	Bingo Hall
473	Casino/Video Lottery Establishment
480	Amusement Park
482	Water Slide Park
488	Soccer Complex
490	Tennis Courts
491	Racquet/Tennis Club
492	Health/Fitness Club
493	Athletic Club
495	Recreational Community Center

Institutional (Land Uses 500–599)

CODE LAND USE

501	Military Base
520	Elementary School
522	Middle School/Junior High School
530	High School
534	Private School (K-8)
536	Private School (K-12)
537	Charter Elementary School
538	School District Office
540	Junior/Community College
550	University/College
560	Church
561	Synagogue
562	Mosque
565	Day Care Center
566	Cemetery
571	Prison

575	Fire and Rescue Station
580	Museum
590	Library

Medical (Land Uses 600–699)

CODE LAND USE

610	Hospital
620	Nursing Home
630	Clinic
640	Animal Hospital/Veterinary Clinic
650	Free-Standing Emergency Room

Office (Land Uses 700–799)

CODE LAND USE

710	General Office Building
712	Small Office Building
714	Corporate Headquarters Building
715	Single Tenant Office Building
720	Medical-Dental Office Building
730	Government Office Building
731	State Motor Vehicles Department
732	United States Post Office
733	Government Office Complex
750	Office Park
760	Research and Development Center
770	Business Park

Retail (Land Uses 800–899)

CODE LAND USE

810	Tractor Supply Store
811	Construction Equipment Rental Store
812	Building Materials and Lumber Store
813	Free-Standing Discount Superstore
814	Variety Store
815	Free-Standing Discount Store
816	Hardware/Paint Store
817	Nursery (Garden Center)
818	Nursery (Wholesale)

820	Shopping Center
823	Factory Outlet Center
840	Automobile Sales (New)
841	Automobile Sales (Used)
842	Recreational Vehicle Sales
843	Automobile Parts Sales
848	Tire Store
849	Tire Superstore
850	Supermarket
851	Convenience Market
853	Convenience Market with Gasoline Pumps
854	Discount Supermarket
857	Discount Club
858	Farmers Market
860	Wholesale Market
861	Sporting Goods Superstore
862	Home Improvement Superstore
863	Electronics Superstore
864	Toy/Children's Superstore
865	Baby Superstore
866	Pet Supply Superstore
867	Office Supply Superstore
868	Book Superstore
869	Discount Home Furnishing Superstore
872	Bed and Linen Superstore
875	Department Store
876	Apparel Store
879	Arts and Crafts Store
880	Pharmacy/Drugstore without Drive-Through Window
881	Pharmacy/Drugstore with Drive-Through Window
882	Marijuana Dispensary
890	Furniture Store
895	Beverage Container Recycling Depot
897	Medical Equipment Store
899	Liquor Store

Services (Land Uses 900–999)

CODE	LAND USE
911	Walk-in Bank
912	Drive-in Bank
918	Hair Salon
920	Copy, Print, and Express Ship Store
925	Drinking Place
926	Food Cart Pod
930	Fast Casual Restaurant
931	Quality Restaurant
932	High-Turnover (Sit-Down) Restaurant
933	Fast-Food Restaurant without Drive-Through Window
934	Fast-Food Restaurant with Drive-Through Window
935	Fast-Food Restaurant with Drive-Through Window and No Indoor Seating
936	Coffee/Donut Shop without Drive-Through Window
937	Coffee/Donut Shop with Drive-Through Window
938	Coffee/Donut Shop with Drive-Through Window and No Indoor Seating
939	Bread/Donut/Bagel Shop without Drive-Through Window
940	Bread/Donut/Bagel Shop with Drive- Through Window
941	Quick Lubrication Vehicle Shop
942	Automobile Care Center
943	Automobile Parts and Service Center
944	Gasoline/Service Station
945	Gasoline/Service Station with Convenience Market
947	Self-Service Car Wash
948	Automated Car Wash
949	Car Wash and Detail Center
950	Truck Stop
960	Super Convenience Market/Gas Station
970	Winery

Preface

The *Trip Generation Manual* is a publication of the Institute of Transportation Engineers (ITE). Volume 1 of the publication, the *Desk Reference*, provides a detailed description of new urban and person-based trip data, summarizes key instructional information, presents sample plots, and identifies significant changes from the previous edition. It also contains definitions of the independent variables and terms used in this manual.

Volume 2 of the *Trip Generation Manual* includes a complete set of searchable electronic files including land use descriptions and data plots for all combinations of available land uses, time periods, independent variables, settings, and trip types (vehicle or person). Data contained in this volume are prepared for informational purposes only and do not include ITE recommendations on the best course of action or the preferred application of the data. The information in Volume 2 is based on trip generation studies submitted voluntarily to ITE by public agencies, developers, consulting firms, student chapters, and associations. Users are encouraged to review and become familiar with the Desk Reference prior to using the data contained in Volume 2.

The *Trip Generation Handbook*, 3rd Edition is also included with the *Trip Generation Manual*. The *Trip Generation Handbook*, 3rd Edition (Publication Number RP-028D) replaces the *Trip Generation Handbook*, 3rd Edition, *An ITE Proposed Recommended Practice* (Publication Number RP-028C, August 2014). This report has the following two primary purposes: to provide instruction and guidance in the proper use of data presented in the *Trip Generation Manual* and to provide information on supplemental issues of importance in estimating trip generation for development sites. The updated *Handbook* provides new guidance on proper techniques for estimating person and vehicular trip generation rates, updates guidance for the evaluation of mixed use developments and the establishment of local trip generation rates, and expands pass-by trip and truck trip generation data.

Also with this edition, users are provided access to a new Trip Generation web app—ITETripGen. This desktop application allows electronic access to the entire trip generation dataset with numerous filtering capabilities including site setting (i.e., rural, suburban, urban), geographic location, age of data, development size, and trip type (person or vehicle trips). Instructions for using ITETripGen are included within the app.

Acknowledgments

Trip Generation Manual, 10th Edition is a result of many months of concerted effort by dedicated volunteers, contactors, and ITE Headquarters staff.

ITE volunteers contributed many hours of timely review and feedback to this project. ITE is particularly appreciative of the efforts put forth by the *Trip Generation* Expert Reviewer and Urban Trip Generation Committees. These committees' dedicated service, expertise, and insight contributed immensely to the completion of this resource.

Kevin G. Hooper (F), Kevin Hooper Associates, served as the technical lead for the project and was responsible for assembling and analyzing all data received, developing new urban- and person-based content, and conducting statistical analyses and validation for the 10th Edition.

Lisa M. Fontana Tierney (F), ITE Traffic Engineering Senior Director, served as project manager for the publication, assisted in the development of the technical content for the report, and coordinated the project and volunteer activities.

ITE Technical Communications Specialist Deborah Rouse edited and managed the production of the publication.

Special thanks are extended to Transoft Solutions for providing programming support that enabled modifications to the existing customized database program and for the development of the ITETripGen web app.

Finally, ITE expresses its appreciation to the many agencies, firms, students, and other individuals who have provided data to this effort.

The following members of the *Trip Generation* Expert Review and Urban Trip Generation Committees provided technical guidance and review of this publication and the new electronic ITE data collection entry system:

Qingyi Ai (M), ARCADIS US, Inc.	Scott Harney (M), Pennoni Associates, Inc.
Raul Avelar (M), Texas A&M Transportation Institute	Lee-Jung Kim (M), AKRF
Paul Basha (M), City of Scottsdale, AZ	Amit Kothari (F), Lawrence Berkeley National Laboratory
Brian S. Bochner (H), Texas A&M Transportation Institute	Ransford S. McCourt (F), DKS Associates
Christopher L. Brehmer (M), Kittelson & Associates, Inc.	Adam N. Miles, City of Spokane, WA
T. William Brockenbrough (M), Delaware Department of Transportation	Edward Y. Papazian (F), Kimley-Horn and Associates, Inc.
Kelly Clifton, Portland State University	Sajjad Rasheed (M), TEC Engineering, Inc.
Kristi Currans (S), Portland State University	Michael Reese (M), North Carolina Department of Transportation
Darlene A. Danehy (M), Psomas	Joseph A. Regis (M), Robert E. Hamilton Consulting Engineers, Inc.
Debbie M. Dantin (M), Dantin Consulting, LLC	James Saag (F), Retired
Stephanie Dock (M), District Department of Transportation	Donald Samdahl (F), Fehr & Peers
Garrett Donaher (M), City of St. John's, Newfoundland and Labrador, Canada	Vijay Sivaraman (F), AirSage
Brian Dempsey (F), Provident Design Engineering, PLLC	Andrew Smigielski (M), Southwest Traffic Engineering, LLC
Patrick Gibson (F), Gibson Transportation Consulting, Inc.	Gary Sokolow (M), Florida Department of Transportation
Rebecca Goldberg (M), Cameron Engineering & Associates, LLP	Eric J. Tripi (M), Parsons Corporation
Daniel K. Hardy (M), Renaissance Planning Group	Betty Tustin (M), The Traffic Group, Inc.
	Bradley W. Yarger (M), Yarger Engineering, Inc.
	Diane B. Zimmerman (M), CDM Smith

(Letters in parentheses indicate ITE member grade: M—Member, F—Fellow, H—Honorary, S—Student Member)

Introduction

Purpose

The purpose of this manual is to present a summary of the trip generation data that have been voluntarily collected and submitted to ITE. This manual represents the 10th full edition and incorporates data from the previous nine editions as well as the supplementary informational reports titled *February 1995 Update to the Fifth Edition* (Publication Number IR-080) and *Trip Generation Characteristics of Traditional and Multiplex Movie Theaters* (Publication Number IR-106). As additional trip generation data become available, they will be distributed through the periodic update of this resource. Instructions and guidance on the proper use of the data presented in Volume 2 have been provided in Volume 1, *Desk Reference*.

Contents of the Manual

Volume 1, *Desk Reference* provides a detailed description of new urban- and person-based trip data, summarizes key instructional information, presents sample plots, and identifies significant changes from the previous edition. It also contains definitions of the independent variables and terms used in this manual. Users are encouraged to review and become familiar with the *Desk Reference* prior to using the data contained in Volume 2.

Volume 2 is intended for use in estimating the number of trips that may be generated by a specific land use. This volume contains a complete set of searchable electronic files including land use descriptions and data plots for all combinations of available land uses, time periods, independent variables, settings, and trip types (vehicle or person). Trip generation rates and equations have been developed for the average weekday, Friday, Saturday, and Sunday; the weekday morning and evening peak hours of the generator; the weekday morning and evening peak hours that occur during the traditional commuting peak hours of the adjacent street traffic (that is, 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m.); and the Saturday and Sunday peak hours of the generator. In some cases, limited data were available; thus, the statistics presented may not be truly representative of the trip generation characteristics of a particular land use. Further information on the cautions and limitations of the data contained in this manual is presented in Chapter 4, "Description of the Database." Volume 2 also includes an appendix with time of day distributions for all land uses for which data are available. Data contained in this volume are prepared for informational purposes only and do not include ITE recommendations on the best course of action or the preferred application of the data. The information in Volume 2 is based on trip generation studies submitted voluntarily to ITE by public agencies, developers, consulting firms, student chapters, and associations.

The *Trip Generation Handbook*, 3rd Edition (Publication Number RP-028D) has the following two primary purposes: to provide instruction and guidance in the proper use of data presented in the *Trip Generation Manual* and to provide information on supplemental issues of importance in estimating trip generation for development sites. The updated *Handbook* provides new guidance on proper techniques for estimating person and vehicular trip generation rates, updates guidance for the

evaluation of mixed use developments and the establishment of local trip generation rates, and expands pass-by trip and truck trip generation data.

The Trip Generation web app—ITETripGen—is a desktop application that allows electronic access to the entire Trip Generation dataset with numerous filtering capabilities including site setting (i.e., rural, suburban, urban), geographic location, age of data, development size, and trip type (person or vehicle trips).

About the Data

The average trip generation rates in this manual represent weighted averages from studies conducted throughout the United States and Canada since 1980. The previous editions of this manual contained data dating back to the 1960s; the 10th edition database was refined to ensure relevancy of its contents by removing older data points.

Historically, data included in the *Trip Generation Manual* were primarily collected at suburban locations having little or no transit service, nearby pedestrian amenities, or travel demand management (TDM) programs. The current edition of this manual vastly expands the dataset and includes a range of sites including central city office towers, walkable midtown commercial districts, mid-rise apartments near rail transit stations, suburban residential subdivisions, and rural wineries. The *Trip Generation Manual* data plots are organized by the setting of the sites represented by data points. More information on location type and setting can be found in Chapter 6, “Urban Trip Generation.”

When practical, the user is encouraged to supplement the data in this document with local data that have been collected at similar sites. Additional data should be submitted to ITE for possible inclusion in subsequent editions. Data can be submitted electronically via an online data collection website at www.itedatasubmission.org, through hard copy data collection forms that can be found on the ITE website at www.ite.org/tripgeneration, or through direct transmittal of electronic files to the ITE Trip Generation email address presented below.

Questions and comments regarding *Trip Generation* should be addressed to:

Institute of Transportation Engineers
1627 Eye Street, NW, Suite 600
Washington, DC 20006
Telephone: 202-785-0060
Fax: 202-785-0609
www.ite.org
email: tripgen@ite.org

2 | Changes Since the Ninth Edition

The 10th edition of *Trip Generation Manual* has undergone several significant changes in content as compared to the ninth edition. Twenty-two new land use classifications and data from more than 1,700 sites have been added. Further, given the significant amount of new data added to the database, the database was refined to ensure relevancy of its contents by removing all data prior to the year 1980. The addition of new data, elimination of older data, and re-examination of existing data resulted in several changes to land use codes, independent variables, and land use descriptions. Specific changes are too numerous to identify in their entirety but the significant changes are described in the following sections.

Importantly, in addition to substantial content changes, the trip generation database has also been expanded to include both vehicle and person trip generation data for urban, suburban, and rural settings. The trip generation data have been disaggregated by area of each study site, enabling the development of separate databases for a range of urban, suburban, and rural settings. *Trip Generation Manual* data can now be directly and explicitly used for the estimation of trip generation for development in multi-use urban areas. Additional information on how to use this manual for urban trip generation estimates can be found in Chapter 6, “Urban Trip Generation.”

Also new to the 10th Edition is the new Trip Generation web app—ITETripGen. This new desktop application allows electronic access to the entire Trip Generation dataset with numerous filtering capabilities including site setting, geographic location, age of data, development size, and trip type (person or vehicle trips). This new tool also allows users to create customized data plots and provides the ability to expand portions of existing graphs to better examine individual data points.

Land Use Codes

A large amount of new data has been collected since the ninth edition was published. These data collection efforts have resulted in the addition of the following 22 new land uses:

- Specialty Trade Contractor (180)
- Off-Campus Student Apartment (225)
- Mid-Rise Residential with 1st-Floor Commercial (231)
- High-Rise Residential with 1st-Floor Commercial (232)
- Rock Climbing Gym (434)
- Trampoline Park (436)
- Professional Baseball Stadium (462)
- Bingo Hall (470)
- Charter Elementary School (537)
- School District Office (538)
- Fire and Rescue Station (575)
- Free-Standing Emergency Room (650)
- Small Office Building (712)
- Farmers Market (858)

- Marijuana Dispensary (882)
- Beverage Container Recycling Depot (895)
- Liquor Store (899)
- Food Cart Pod (926)
- Fast Casual Restaurant (930)
- Car Wash and Detail Center (949)
- Super Convenience Market/Gas Station (960)
- Winery (970)

In an effort to continually provide data that accurately reflects the composition of each land use, some data were reassigned to other land uses, corrected from previous editions, or removed from the database. Several land uses were also renumbered to facilitate a more logical grouping of related land uses. The following list summarizes these changes:

- Waterport/Marine Terminal (010) was removed due to the age of the data for this land use.
- Park-and-Ride Lot with Bus Service (090) was changed to Park-and-Ride Lot with Bus or Light Rail Service (090). The existing land use Light Rail Transit Station with Parking (093) was removed and the data from this land use was added to the new land use Park-and-Ride Lot with Bus or Light Rail Service (090).
- General Heavy Industrial (120) was removed due to the age of the data for this land use.
- High-Cube Warehouse/Distribution Center (152) was removed and the data were reclassified into four new related land uses as follows: High-Cube Transload and Short-Term Storage Warehouse (154), High-Cube Fulfillment Center Warehouse (155), High-Cube Parcel Hub Warehouse (156), High-Cube Cold Storage Warehouse (157).
- Apartment (220), Low-Rise Apartment (221), High-Rise Apartment (222), Mid-Rise Apartment (223), Rental Townhouse (224), Residential Condominium/Townhouse (230), Low-Rise Residential Condominium/Townhouse (231), High-Rise Residential Condominium/Townhouse (232), and Luxury Condominium/Townhouse (233) were removed and the data were reclassified into the following new land uses: Multifamily Housing (Low-Rise) (220), Multifamily Housing (Mid-Rise) (221), Multifamily Housing (High-Rise) (222).
- City Park (411), County Park (412), Beach Park (415), Regional Park (417) were consolidated into a new land use Public Park (411).
- Water Slide Park (414) was renumbered Water Slide Park (482).
- National Monument (418) was removed due to the age of the data for this land use.
- Live Theater (441) was removed due to the age of the data for this land use.
- Movie Theater with Matinee (444) was changed to Movie Theater (444); Movie Theater without Matinee (443) was removed and the data were reclassified as Movie Theater (444).
- Zoo (481) was removed due to the age of the data for this land use.
- Lodge/Fraternal Organization (591) was removed due to the age of the data for this land use.
- Specialty Retail Center (826) was removed. Data from the land use was reclassified to existing land uses.
- Automobile Sales (New) (840) was added as a new land use and Automobile Sales (841) was renamed Automobile Sales (Used) (841); new data received indicated that new and used automobile sales have different trip generation rates.
- Convenience Market (Open 24 Hours) (851) was renamed as Convenience Market (851); Convenience Market (Open 15-16 Hours) (852) was removed and the data were reclassified as Convenience Market (851).

- DVD/Video Rental Store (896) was removed since standalone stores that fit this description are no longer being developed.
- Gasoline/Service Station and Car Wash (946) was removed and the data were reclassified to existing land uses. An examination of the data for this land use indicated that the presence of a car wash does not have a demonstrable effect on trip generation rates.

Land Use Descriptions

Several land use descriptions were modified to provide additional clarification and to more accurately reflect the studies contained within the Trip Generation database. The following section lists the land uses that were changed significantly:

- The High-Cube Warehouse/Distribution Center-related land uses underwent specialized consideration through a commissioned study titled *High-Cube Warehouse Vehicle Trip Generation Analysis*, published in October 2016. The results of this study have been incorporated into the 10th Edition *Trip Generation Manual* resulting in the removal of the existing land use code 152 and reclassification of the data into four new land use codes and descriptions. For more information, please visit the ITE website at <http://library.ite.org/pub/a3e6679a-e3a8-bf38-7f29-2961becdd498> where the study is posted.
- The existing data from Apartment (220) was examined to identify the number of floors contained in each of the sites included in this land use. Each data point was then reclassified into the appropriate category (low-rise, mid-rise, and high-rise). If the number of floors could not be determined, the data points were deleted from the database. Further, all existing residential land uses that included multifamily dwellings (apartments, townhouses, and condominiums) were consolidated into the following three new multifamily housing land use categories: Multifamily Housing (Low-Rise) (220), Multifamily Housing (Mid-Rise) (221), Multifamily Housing (High-Rise) (222).
- The description for Business Hotel (312) was expanded to include recreational travelers to more accurately reflect the sites that are included in this land use.
- The set of land uses that contain Gasoline/Service Stations and Convenience Markets were re-examined and data was re-assigned to ensure that the data accurately reflect the existing land use definitions. Further, a new land use—Super Convenience Market/Gas Station (960)—was created for large sites that contain both significant convenience market square footage and a significant number of vehicle fueling positions. These sites were analyzed using multiple variable regression analysis to more accurately reflect significant presence of both areas of business.

Definition of Terms, Independent Variables, and Time Periods

Numerous terms, independent variables, and time periods were added to the 10th Edition. See Chapter 3 for a current definition of the all terms, independent variables, and time periods used in the *Trip Generation Manual*.

Statistics

Regression Analysis

Regression analysis provides a tool for developing an equation that defines the line that “best fits” the data. This specific mathematical relationship between trips and the related independent variable is defined as the “fitted curve equation.” Traditionally, all of the plots in the manual have included only a single independent variable and have been displayed as either linear or logarithmic fitted curve equations.

The 10th Edition introduces multi-variable regression equations for several land uses for which (1) a single independent variable is not producing a desired level of precision in the trip end estimate and (2) there is a pair of logical independent variables from which to derive the multi-variable calculations. The 10th Edition presents multi-variable equations for several time periods for LUC 231 (Mid-Rise Residential with 1st-Floor Commercial) and for LUC 960 (Super Convenience Market/Gas Station).

Land Uses with One Data Point

Prior to the release of this edition, land use/independent variable/time period combinations that resulted in only a single point were published as “one observation tables” and included on the land use description pages. In the 10th Edition, the one observation tables have been replaced by single point plots. All plots with five or fewer data points include the statement “Caution—Small Sample Size” to warn users of the limited data set.

Corrected Standard Deviation Values

Standard deviation is a measure of data dispersion relative to the calculated average. A low standard deviation represents less dispersion. Standard deviation is provided when there are three or more data points. The data plots in *Trip Generation Manual*, 9th Edition included miscalculated values for weighted standard deviation. The 10th Edition includes the correct values. The method used for calculation of weighted standard deviation is demonstrated in Appendix J of the *Trip Generation Handbook*, 3rd Edition.

Other

In the 10th Edition, trip generation hourly variation tables that were previously contained on the land use description pages have been moved to Appendix A of *Trip Generation Manual*, Volume 2.

A new electronic data collection system has been developed to facilitate an improved process for submitting data to ITE to be considered for inclusion in the *Trip Generation Manual*. The new online data collection site is available at www.itedatasubmission.org. Hard copy Trip Generation Data Collection Forms are also available on the ITE website at: <http://www.ite.org/tripgeneration>.

3 | Definition of Terms

The definitions presented in this chapter are intended for use in the *Trip Generation Manual*. Additional terms intended for use with the *Trip Generation Handbook* can be found in Appendix A of the *Trip Generation Handbook*.

The terms are grouped as follows:

- Trip Types and Trip Modes
- Setting/Location
- Time Periods
- Independent Variables
- Data Page Terms

Trip Types and Trip Modes

Person Trip—a trip made by any mode of travel by an individual person from an origin to a destination. Every trip made anywhere by a person is a person trip. If three people leave a development site in a single vehicle, this is counted as three person trips.

Personal Passenger Vehicle—includes (1) any automobile, van, SUV, motorcycle, moped, or light truck driven by a private individual for personal use; (2) taxi, paratransit, or vanpool (including airport shuttle); and (3) pick-up truck not being used for commercial purposes.

Trip or Trip End—a single or one-direction person or vehicle movement with either the origin or the destination (exiting or entering) inside a study site. In technical terms, a trip has an origin and a destination at its respective ends (known as trip ends). Each trip end is a part of a trip. For site trip generation, the analyst is usually interested in trips entering and exiting a single site.

Vehicle Trip—the movement of a personal passenger vehicle or truck that transports a person across the site cordon line. A person can cross the cordon line as a passenger in a vehicle or as a pedestrian having been transported to the site in a vehicle. For example, if a person drives a personal passenger vehicle from home, parks off-site, and walks from the parking facility to an office building, the trip is considered an entering vehicle trip generated by the office building (as well as an exiting vehicle trip at the place of residence). However, if a person is transported to the vicinity of a site in a bus or rail transit and walks the remainder of the distance to the site, the trip represents a transit trip and not a vehicle trip.

Setting/Location

Center City Core—the downtown area for a major metropolitan region at the focal point of a regional light- or heavy-rail transit system. This area type is typified by multi-storied buildings, a wide range of land uses, an extensive pedestrian sidewalk network, and shared and priced parking both on-street and in structured garages or surface lots. The area typically has more jobs than residents

and therefore is typically an employment destination. The area also includes the immediate vicinity of the commercial core.

Dense Multi-Use Urban—a fully developed area (or nearly so), with diverse and interacting complementary land uses, good pedestrian connectivity, and convenient and frequent transit. This area type can be a well-developed urban area outside a major metropolitan downtown or a moderate size urban area downtown. The land use mix typically includes office, retail, residential, and often entertainment, hotel, and other commercial uses. The residential uses are typically multifamily or single-family on lots no larger than one-fourth acre. The commercial uses often have little or no setback from the sidewalk. Because the motor vehicle still represents the primary mode of travel to and from the area, there typically is on-street parking and often off-street public parking. The complementary land uses provide the opportunity for short trips within the Dense Multi-Use Urban area, made convenient by walking, biking, or transit. The area is served by significant transit (either rail or bus) that enables a high level of transit usage to and from area development.

General Urban/Suburban—an area associated with almost homogeneous vehicle-centered access. Nearly all person trips that enter or exit a development site are by personal passenger or commercial vehicle. The area can be fully developed (or nearly so) at low-medium density with a mix of residential and commercial uses. The commercial land uses are typically concentrated at intersections or spread along commercial corridors, often surrounded by low-density, almost entirely residential development. Most commercial buildings are located behind the parking area or surrounded by parking. The mixing of land uses is only in terms of their proximity, not in terms of function. A retail land use may focus on serving a regional clientele whereas a service land use may target motorists or pass-by vehicle trips for its customers. Even if the land uses are complementary, a lack of pedestrian, bicycling, and transit facilities or services limit non-vehicle travel.

Rural—agricultural or undeveloped except for scattered parcels and at very low densities.

Time Periods

Average Weekday—a continuous 24-hour period during Monday through Friday. The period can bridge two days.

Average Weekday, Peak Hour of Adjacent Street Traffic—the one hour within the morning and evening weekday commuter peak periods when the combination of site-generated traffic and the traffic on the adjacent street is the highest (typically from data collected Monday through Friday). If the adjacent street traffic volumes are unknown, the peak hour of the adjacent street is assumed to be the one hour when the highest hourly vehicle trips are generated by the site during the weekday commuter peak periods between 7:00 and 9:00 a.m. or 4:00 and 6:00 p.m. Recent studies have indicated that these peak periods have expanded in some heavily populated areas.

Average Weekday, Peak Hour of Generator—the hour of highest volume of traffic entering and exiting the site during the AM or PM on a weekday (typically from data collected Monday through Friday). It may or may not coincide with the peak hour of the adjacent street traffic.

Friday, Peak Hour of Generator—the hour with the highest volume of traffic entering and exiting a site on a Friday. It may occur during either the AM or PM.

Friday, Peak Hour of Adjacent Street Traffic—the one hour within the morning and evening commuter peak periods when the combination of site-generated traffic and the traffic on the adjacent street is the highest on a Friday. If the adjacent street traffic volumes are unknown, the peak hour of the adjacent street is assumed to be the one hour when the highest hourly vehicle trips are generated by the site during the commuter peak periods between 7:00 and 9:00 a.m. or 4:00 and 6:00 p.m.

Saturday, Midday Peak Hour of Generator—the hour with the highest volume of traffic entering and exiting a site on a Saturday between 11 a.m. and 1 p.m.

Saturday, Peak Hour of Generator—the hour with the highest volume of traffic entering and exiting a site on a Saturday. It may occur during either the AM or PM.

Sunday, Peak Hour of Generator—the hour with the highest volume of traffic entering and exiting a site on a Sunday. It may occur in either the AM or PM.

Independent Variables

Acre—a unit of measurement equal to 43,560 sq. ft. and for the purpose of *Trip Generation Manual* used to quantify the total gross area of a development site (including land dedicated to public agencies). The distinction between total acres and total developed acres is not always clearly defined in the site acreage reported to ITE. Therefore, caution should be used with this variable. When submitting data, the analyst should indicate the percent of developed acreage and the total acreage of the property.

AM/PM Peak Hour Traffic on Adjacent Street—the highest hourly volumes of traffic on the adjacent streets during the AM and PM commuter peak periods, respectively (see **Peak Hour of Adjacent Street Traffic** under **Time Periods**). The value includes all traffic on streets abutting the site that have direct access to the development site. Where the site is serviced by some form of service roadway, the adjacent street definition includes any street that leads to the service road and thus may not actually be contiguous to the site. Traffic on travel lanes where road features physically restrict direct access to the development site is excluded.

Attendee—a person who is present on a given occasion, during a given event or at a given place.

Bed—a designated place to sleep for a group quarters resident or medical facility patient. An occupied bed is a bed for which there is an assigned person.

Bedroom—a designated room for sleeping with one or more beds.

Berth—a designated place where a boat can anchor at a marina or wharf.

Bowling Lane—a single lane available for the purposes of bowling.

Cage—a designated location available for the purpose of a single person hitting baseballs or softballs within a contained area.

Campsite—a place used for an overnight stay in the outdoors. An **occupied campsite** is a campsite that is currently being used.

Daily Customer—a person who visits a building in order to conduct personal business at any time during a single day.

Daily Trail User—a person who visits a park and walks along a designated trail at any time during a single day.

Drive-In Lane—an individual lane at a banking facility used for financial transactions. A lane used only for Automated Teller Machine (ATM) transactions is included.

Dwelling Unit—a residential location such as a house, apartment, condominium, townhouse, mobile home, or manufactured home in which people may live. An **occupied dwelling unit** is a dwelling unit in which people currently live.

Employee—a full-time, part-time, or per diem/contract worker. The number of employees refers to the total number of persons employed at a facility, not just those in attendance at the particular hour or day the data are collected.

Family Members—the total number of family members who are considered members of a specific worship facility. **Member** is a similar term.

Fields—any area constructed, equipped, and/or marked for outdoor activities and sports.

Food Cart—a mobile kitchen that enables its operator to market and sell cooked food to customers.

Gaming Position (slot)—an individual seat at which a person may engage in a gaming activity at a slot machine.

Gross Floor Area (GFA)—the sum of the area of each floor level of a building (expressed in square feet), including cellars, basements, mezzanines, penthouses, corridors, lobbies, stores, and offices, that are within the principal outside faces of exterior walls, not including architectural setbacks or projections. Included are all areas that have floor surfaces with clear standing head room (6 ft. 6 in. minimum) regardless of their use. With the exception of buildings containing enclosed malls or atriums, GFA is equal to gross leasable area and gross rentable area. **Occupied gross floor area** refers to GFA within the facility which is currently being utilized. If a ground-level area, or part thereof, within the principal outside faces of the exterior walls is not enclosed, this floor area is considered part of the overall GFA of the building. However, unroofed areas and unenclosed roofed-over spaces, except those contained within the principal outside faces of exterior walls, should be excluded from the area calculations. For the purpose of trip generation calculation, the floor area of all parking garages within the building should not be included in the GFA of the entire building. The majority of land uses in *Trip Generation Manual* use GFA as an independent variable.

Gross Leasable Area (GLA)—the total floor area designed for tenant occupancy and exclusive use, including any basements, mezzanines, or upper floors, expressed in square feet and measured from the centerline of joint partitions and from outside wall faces. For the purpose of trip generation calculation, the floor area of all parking garages within the building should not be included within the GLA of the entire building. GLA is the area for which tenants pay rent; it is the area that produces income for the property owner. **Occupied gross leasable area** refers to GLA within the facility which is currently in use. Leased space that is not in productive use is not considered occupied. In the retail business, GLA lends itself readily to measurement and comparison and it has been adopted by the

shopping center industry as its standard for statistical comparison. Accordingly, GLA is used in *Trip Generation Manual* for shopping centers. For specialty retail centers, strip centers, discount stores and freestanding retail facilities, GLA usually equals GFA.

Holes—a single combination of a tee, fairway, and green on a golf course.

Member—an individual who belongs to a group or organization. **Family Members** is a similar term.

Member Family—a family that belongs to a group or organization.

Movie Screen—a room within a movie theater that contains seats and the presentation of a movie.

Municipal Population—a count of all persons having their primary residence within the municipality.

Net Rentable Area—the sum of floor square footage for all storage units in a self-storage facility. The term is currently used only for Land Use Code 151 (Mini-Warehouse).

Occupied Bed (see **Bed**)

Occupied Dwelling Unit (see **Dwelling Unit**)

Occupied Gross Floor Area (see **Gross Floor Area**)

Occupied Room (see **Room**)

Occupied Parking Space (see **Parking Space**)

Occupied Storage Unit (see **Storage Unit**)

Occupied Unit (see **Unit**)

Parking Space—an individual stall within a parking lot or garage designated for the use of a parked private motor vehicle. An occupied space is a parking space in which a vehicle is parked.

PM Peak Hour Traffic on Adjacent Street (see **AM/PM Peak Hour Traffic on Adjacent Street**)

Resident—a person who resides in the given dwelling unit.

Rink—an enclosed area for skating.

Room—the partitioned part of the inside of a building used for lodging such as a hotel or motel. An **occupied room** is a room that is rented by a lodging guest.

Seat—a place on which an individual can sit; may include a chair or multiple seats may be present on a bench or pew.

Service Bay—the location within an automobile servicing facility, building, or care center where a vehicle can be parked to be inspected and/or repaired.

Servicing Position—a location within a quick-lubrication vehicle shop or other vehicle repair shop at which a vehicle can be serviced. For example, if a quick-lubrication vehicle shop has one service bay that can service two vehicles at the same time, the number of servicing positions is two.

Slope—a single downhill cleared area on which a person can ski.

Storage Unit—a vault rented for the storage of goods in what is typically referred to as a self-storage facility. An **occupied storage unit** is one that is rented. **Unit** is a similar term with a different definition.

Student—a person enrolled in an institution such as a school, college, or day care center on either a full-time or part-time basis. The number of students refers to the total number of persons enrolled at a facility, not just those present at the time the study is conducted.

Tee, Driving Position—a designated position from which a golf ball is struck for practice.

Tennis Court—an indoor or outdoor facility specifically designed for an individual tennis match.

Unit—a group of rooms intended for dwelling within Land Use Code 255 (Continuing Care Retirement Community). An occupied unit is a unit for which a person is assigned. **Storage Unit** is a similar term with a different definition.

Vehicle—as used as an independent variable for residential land use codes includes any automobile, van, SUV, motorcycle, or light truck parked overnight within a residential area. For Land Use Code 501 (Military Base), the definition of vehicle is any vehicle authorized to enter the facility.

Vehicle Fueling Position—is defined by the number of vehicles that can be fueled simultaneously at a service station. For example, if a service station has two fuel dispensing pumps with hoses on each side of each pump, where only one vehicle can be fueled at a time on each side, the number of vehicle fueling positions is four.

Vendor—a single person or company offering something for sale.

Wash Stall—a location within either a self-service or automated car wash where a vehicle can be parked to be washed.

Data Page Terms

Average Number of [Independent Variable]—the average value of the independent variable for data presented on the specific data page.

Average Rate (or Weighted Average Rate or Average Trip Rate)—the weighted average number of vehicle or person trips entering or exiting a development site per one unit of the independent variable. It is calculated by dividing the sum of all trips for all contributing data point sites by the sum of all independent variable units for all contributing data point sites. The weighted average rate is used rather than the average of the individual rates because of the variance within each data set or generating unit. Data sets with a large variance will over-influence the average rate if they are not weighted. The data plot includes a dashed line corresponding to the weighted average rate, extending between the lowest and highest independent variable values for data points.

Trip Ends, T—vehicle or person trips, the dependent variable in the data plot; shown on the y-axis.

Coefficient of Determination (R^2)—the percent of the variance in the number of trips associated with the variance in the independent variable value. If the R^2 value is 0.75, then 75 percent of the variance in the number of trips is accounted for by the variance in the size of the independent variable. As the R^2 value approaches 1.0 the better the fit; as the R^2 value approaches zero, the worse the fit.

Directional Distribution—the percent of total trips entering and exiting a site during the indicated time period.

Fitted Curve and Fitted Curve Equation—the single-variable regression analysis of the independent and dependent variable expressed in an optimal mathematical relationship. If the variables are related linearly, the equation has the following format: $T = aX + b$. In a logarithmic relationship, the equation has the following format: $\ln(T) = a \ln(X) + b$. The data plot includes a solid line corresponding to the equation, extending between the lowest and highest independent variable values for data points.

Independent Variable, X—a physical, measurable, and predictable characteristic that describes the study site or baseline site (for example, gross floor area) and that has a direct relationship to the variation in the number of trips generated by a land use. The term “explanatory variable” is also used.

Number of Studies—the total number of studies reported on the specific data page.

Range of Rates—the minimum and maximum trip generation rates from all the studies reported.

Standard Deviation—a measure of data dispersion relative to the calculated average. The lower the standard deviation, the less data dispersion there is in the data and the better the data fit to the average rate. In *Trip Generation Manual*, the reported standard deviation is based on the weighted average, not the mean.

Study Site—a data point plotted on the graph based on a study performed for the specific land use code.

4 | Description of the Database

The data analyzed in this document were contributed on a voluntary basis by various state and local governmental agencies, consulting firms, individual transportation professionals, universities and colleges, developers, associations, local sections, districts, and student chapters of ITE. In many cases, the data were originally contained in published reports or unpublished analyses conducted by such groups. The sources of these reports or analyses are listed in Appendix A. The source numbers for studies contained in each land use are listed on the land use description pages in Volume 2.

ITE Headquarters conducted no original field surveys. The amount of data submitted for an individual site varied from as little as one peak-hour volume to seven days of directional hourly volumes. All data have been combined to maximize the size of the database for each land use and each time period. Data received were initially examined by ITE staff for validity and reasonableness before being entered into the comprehensive database.

Data Collection

Some of the data submitted were collected using automatic counters configured to count vehicular traffic entering and exiting a site. The sites selected for counting did not include through traffic, and counts were taken on driveways of sufficient length to avoid the double counting of turning vehicles. In some cases, counts were non-directional and therefore did not distinguish between entering and exiting vehicles. Manual counts often supplemented the automatic counts to obtain vehicle occupancy and classification; to check the reliability of the automatic counters; and to obtain directional counts during peak periods when a non-directional automatic count was being conducted. In other cases, only manual counts of vehicles or persons were conducted during peak periods. For some sites, the count data were supplemented by intercept surveys to determine travel modes of persons that enter or exit the site on foot.

Additional information regarding site characteristics was obtained through Internet searches, personal interviews, actual measurements, or telephone conversations.

Data Analysis and Storage

The statistical analyses conducted for the *Trip Generation Manual* were derived from a customized software program and database developed for ITE. Each data record was referenced in the database by a source number; the month and year of the vehicle or person count; the state or province; the setting/location; and a three-digit land use code. Data for 176 land uses are classified within 10 major land use categories. Additional land uses are continuously added to the database as data become available.

Data Age

The database originally compiled to produce this manual contained data extending back to the early 1960s. However, based on the significant amount of new data received for the 10th Edition update and a detailed review of the age of data in the existing database, ITE decided to eliminate all data collected prior to 1980. As future editions are produced, the age of data will be evaluated and additional data will be considered for removal. The deletion of pre-1980 data resulted in the removal of several non-critical land uses, independent variables, and time periods from the existing database.

With the inclusion of the new web app—ITETripGen—users of the *Trip Generation Manual* now have the ability to create customized data plots based on the age of data, site geography, setting, and a range of values for the independent variable. Electronic data sorts provide a filtered subset of the entire dataset for individual review and analysis. This new ability to filter the data may provide useful insights into the data. However, the analyst should exercise caution when interpreting a data subset. The data subset does not necessarily constitute a balance of potential land use characteristics across the database. As the database is filtered and the database size diminishes, the less likely the possibility that a reasonable cross-section is achieved.

Variations in the Statistics

Variations in trip generation characteristics for specific land uses are reflected in the range of rates, standard deviation, and coefficient of determination (R^2) value. (See Chapter 5, “Description of Data Plots and Reported Statistics,” for additional details on these topics.) These variations may be due to a small sample size, individual marketing of the site, economic conditions of the business market, geographic location of the sites studied, or unique characteristics of the specific site. Accordingly, judgment must be exercised in the use of the statistics in this manual.

Other sources of variation include different lengths of traffic count duration and the time of year the traffic volumes were counted; that is, daily and seasonal variations may exist for some land uses. Further, variations may also exist based on geographic location. The ITETripGen web app allows users to examine filtered sets of data based on geographic location by regions within the U.S. as well as filtering both U.S. and Canadian sites.

Limitations of the Data Plots

The plots presented in the *Trip Generation Manual* cover only the range of independent variables for which data are available. Caution should be used if extrapolating the data beyond the ranges provided because no information has been supplied to document trip generation characteristics beyond the given ranges.

It should also be noted that in some cases, because of the limited sample size and variation in the data received, the projected trip generation estimate for the peak hour of the adjacent street traffic exceeds the trip generation estimate for the peak hour of the generator. By definition, this is impossible. In these isolated cases, knowledge of the project site and engineering judgment should be used to select the appropriate trip generation approximation.

5 | Description of Data Plots and Reported Statistics

Data Plots

Figure 5.1 is an example of the statistical and descriptive information available for the majority of the land uses contained in Volume 2 of the *Trip Generation Manual*. This sample data page provides explanatory notes describing each element of the figure.

Data plots provide the most fundamental display of the variance within the database. It should be emphasized that the data points represented on the plots are not trip generation rates; rather, they are the observed number of trips, plotted against the size of the independent variable.

Some plots may have the statement “Caution—Small Sample Size” printed above the plot area. This statement is displayed when five or fewer studies comprise the data set. For the first time, in the 10th Edition of the manual, data plots are provided for all combinations of land use, independent variable, time period, trip type (vehicle or person), and setting, even for a single point. Extreme caution should be used in applying data samples that are based on only one data point.

Some plots generated through the ITETripGen web app may also have the statement “Caution-Incomplete Data Set” printed above the plot area. This statement is displayed if the dataset used in the plot includes only a subset of the entire database based on the filtering criteria provided in the ITETripGen web app.

A description of the equations on the data plots is contained in Chapter 7, “Instructions.”

Reported Statistics

Average Trip Rate

The average trip generation rates displayed in this manual were calculated on the basis of a weighted **average trip rate**. The weighted average trip rate was used rather than the average of the individual rates because of the variance found within each data set. Sites with a large variance from the mean would have over-influenced the average rate had they not been weighted.

Standard Deviation for the Weighted Average Trip Rate

The **standard deviation** is a measure of how widely dispersed the data points are around the calculated average. The lower the standard deviation—meaning less dispersion in the data—the better the data fit. In this document, the statistics reported are based on a “weighted average,” not an “arithmetic average.” Therefore, the standard deviation is an approximation and not statistically correct.

Regression Analysis

The customized software used for the 10th Edition of the *Trip Generation Manual* examines the independent variable and the number of trips in order to generate a regression curve, a regression equation, and a coefficient of determination (R^2) for each land use. The **coefficient of determination** is defined as the percent of the variance in the number of the trips associated with the variance in the size of the independent variable. If the R^2 value is 0.75, then 75 percent of the variance in the number of trips is accounted for by the variance in the size of the independent variable. As the R^2 value increases toward 1.0, the better the fit; as the R^2 value decreases toward 0, the worse the fit. A standard formula for calculating R^2 can be found in a statistics textbook.

The general forms of the regression equations used in this manual include the following:

$$T = aX + b \text{ (linear)}$$

$$\ln(T) = a\ln(X) + b \text{ (logarithmic)}$$

The objective in developing the relationship between X (the independent variable) and T (the dependent variable or number of trips) is to determine the values of the parameters a and b . As a result, the expected error in estimating the dependent variable (the number of trips) given the estimates of the independent variable will be minimized.

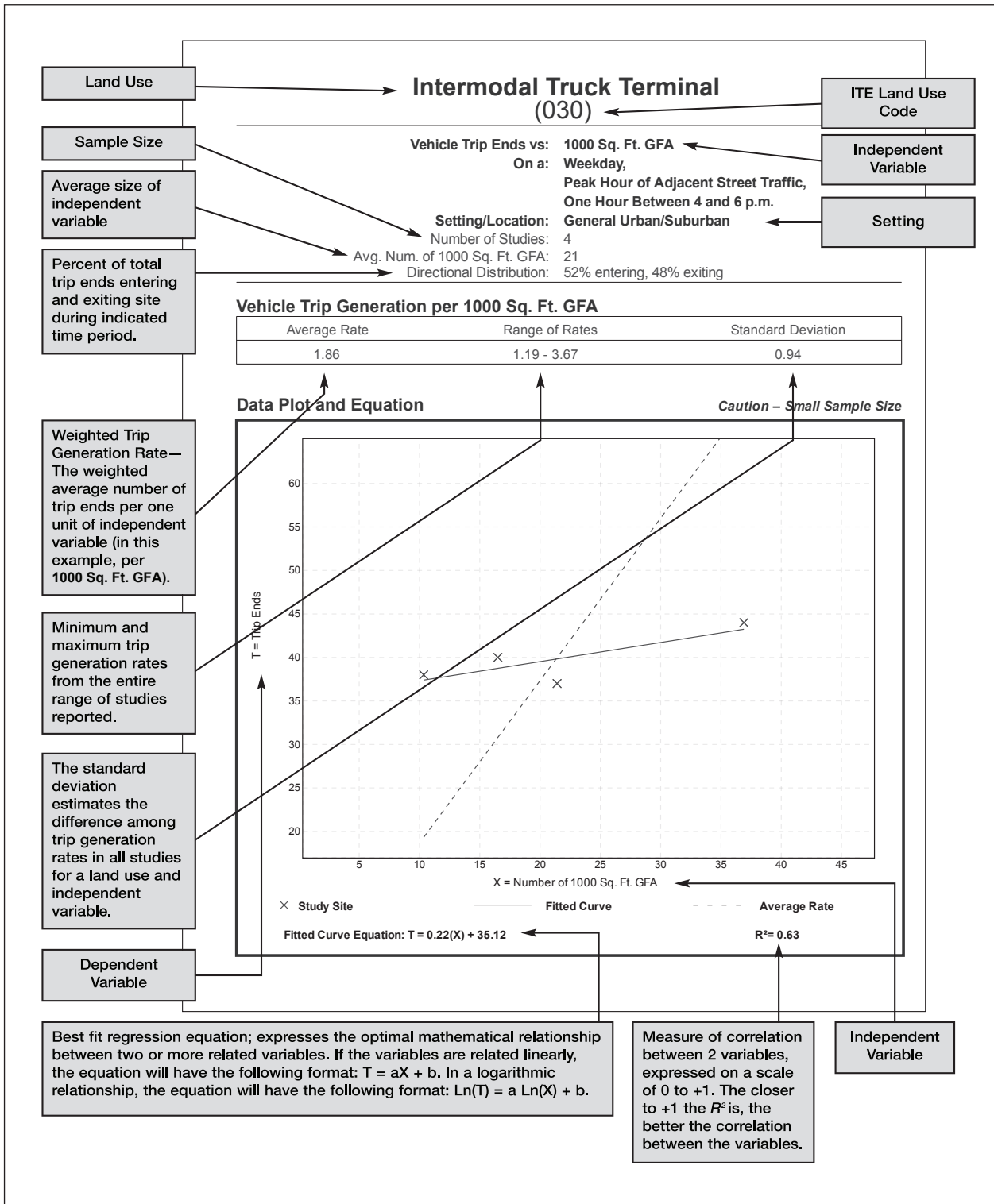
The software program selects and plots the regression equation with the highest R^2 value. The regression equation appears on the graph as a solid line to show how well it represents the actual data points.

Best fit regression curves are shown in this manual only when each of the following three conditions is met:

1. The R^2 is greater than or equal to 0.50.
2. The sample size is greater than or equal to 4.
3. The number of trips increases as the size of the independent variable increases.

It should be noted that there are several instances when the regression curves result in equations with significantly large y-intercepts. The use of these equations may produce illogical trip-end estimates for independent variables that are significantly less than the average-sized value. For such cases, users are cautioned in applying data and are referred to Chapter 3, "Process for Estimating Trips Generated by a Study Site," of the *Trip Generation Handbook*, 3rd Edition.

Figure 5.1 Sample Data Page in *Trip Generation Manual*



Source: *Trip Generation Manual*, 10th Edition, Institute of Transportation Engineers, Washington, DC, 2017.

6 | Urban Trip Generation Data

The trips generated by a particular development site are a function of many factors, beginning with the specifics of the land use at the site (e.g., its size, number of employees, number of residents). The *Trip Generation Manual* contains 176 different land use classifications and numerous independent variables that describe site characteristics.¹ For the purpose of estimating vehicle trips in a suburban setting, these characteristics are typically sufficient to enable an accurate estimate. However, in an urban setting where there are opportunities for walk, bike, and transit trips, the number of vehicle trips may be affected.

There is increasing potential for walk trips as development densities increase in the proximity of the site and as activity at the nearby development complements a particular site. The pedestrian environment (e.g., sidewalk continuity, slow vehicle speeds, accessibility, protected street crossings) and bicyclist environment (e.g., bicycle lanes) enable and encourage walk and bike trips that otherwise would be made by vehicle or not at all. The availability and cost of parking (both on-site and off-site) and the frequency and type of transit service and its proximity can also affect the choice of travel mode (and, as a result, the number of vehicle trips generated by the site).

The ITE *Trip Generation Manual* contains data for a range of new settings that includes central city office towers, walkable midtown commercial districts, mid-rise apartments near rail transit stations, suburban residential subdivisions, and rural wineries. In some settings, only a small percentage of site-generated trips are as a pedestrian, bicyclist, or transit patron. In other settings, the number of non-vehicle trips is significant and the number of vehicle trips is significantly reduced. To enable the user to better understand these impacts, the *Trip Generation Manual* provides data plots that are organized by setting type.

Settings Used in Trip Generation Database

The 10th Edition of *Trip Generation Manual* presents data plots and statistics that illustrate the differences in trip generation at urban and suburban sites. The setting of each study site included in the ITE trip generation database is classified as one of the following:

- Center City Core
- Dense Multi-Use Urban
- General Urban/Suburban
- Rural

¹ There are many other characteristics that can affect trip-making at a site. For example, an apartment building with entirely one-bedroom units might have different trip-making attributes from an apartment building with entirely two-bedroom units. Another example is, in a general office building, the employee density and level of external visitation can vary widely between the many building tenants and therefore would affect employee trip-making. Socio-economic factors (e.g., income levels, levels of auto availability) can also affect trip-making. For land uses with a significant number of data points, the sites in the trip generation database are likely to represent a wide cross-section of these characteristics.

The **Center City Core** is the downtown area for a major metropolitan region that is the focal point of a regional light- or heavy-rail transit system. This area type is typified by multi-storied buildings, a wide range of land uses, an extensive pedestrian sidewalk network, and shared and priced parking both on-street and in structured garages or surface lots. The area typically has more jobs than residents and therefore is an employment destination. The area includes the immediate vicinity of the commercial core.²

An area designated as **Dense Multi-Use Urban** in the *Trip Generation Manual* is a fully developed area (or nearly so), with diverse and complementary land uses, good pedestrian connectivity, and convenient and frequent transit. This area type can be a well-developed urban area outside a major metropolitan downtown or a moderate size urban area downtown.

The land use mix typically includes office, retail, residential, and often entertainment, hotel, and other commercial uses. The residential uses are typically multifamily or single-family on lots no larger than one-fourth acre. The commercial uses often have little or no setback from the sidewalk. Because the motor vehicle still represents the primary mode of travel to and from the area, there typically is on-street parking and often public off-street parking.

The complementary land uses provide the opportunity for short trips within the Dense Multi-Use Urban area, made conveniently by walking, biking, or transit. The area is served by significant transit (either rail or bus) that enables a high level of transit usage to and from area development.

An area designated as **General Urban/Suburban** in the *Trip Generation Manual* is an area associated with almost homogeneous vehicle-centered access. Nearly all person trips that enter or exit a development site are by personal passenger or commercial vehicle.

The area can be fully developed (or nearly so) at low-medium density with a mix of residential and commercial uses. The commercial land uses are typically concentrated at intersections or spread along commercial corridors, often surrounded by low-density, almost entirely residential development. Most commercial buildings are located behind or surrounded by parking.

The mixing of land uses is only in terms of their proximity, not in terms of function. A retail land use may focus on serving a regional clientele or a services land use may target motorists or pass-by vehicle trips for its customers. Even if the land uses are complementary, a lack of pedestrian, bicycling, and transit facilities or services limit non-vehicle travel.

Sample Urban and Person Data Plots

The following pages present data plots and statistics for a sampling of the urban trip generation presented in the *Trip Generation Manual*. A comparison between the plots illustrates the differences in trip-making between general urban/suburban, dense multi-use urban, and center city core settings.

² The current *Trip Generation Manual* database includes data for Center City Core sites for only major metropolitan areas served by light- or heavy-rail. For a downtown area in a major metropolitan area without rail, neither the current Center City Core nor Dense Multi-Use Urban data are directly relevant. As ITE compiles and analyzes data for those areas, the *Trip Generation Manual* data plots and setting definitions will be updated accordingly. In the interim, the *Trip Generation Handbook* provides guidance on how to adapt data to conform to any site setting.

The first set of data plots (Figures 6.1–6.3) represent vehicular trips as General Office Buildings (Land Use Code 710) during the peak hour of adjacent street traffic, between 7 and 9 a.m., on a weekday with gross floor area as the independent variable. Figure 6.1 presents vehicle trips for a general urban/suburban setting. Figures 6.2 and 6.3 also show data plots with vehicle trips for a general office building in dense multi-use urban and center city core settings, respectively. The weighted average vehicle trip rates are 1.16, 0.82, and 0.50 for the general urban/suburban, dense multi-use urban, and center city core settings, respectively. The lower vehicle trip rates for the more urban settings reflect the increased level of non-vehicle travel modes (i.e., walking, biking, and riding transit).

Figures 6.4–6.6 show person trips at general office buildings for the three same settings. These person trip plots demonstrate approximately the same weighted average person trip rate, for this time period, for the dense multi-use urban (1.25) and center city core (1.24) settings and a higher rate for the general urban/suburban setting (1.44).

Figures 6.7–6.12 contain data plots for Multifamily Housing (Mid-Rise) (Land Use Code 221) during the peak hour of adjacent street traffic, between 7 and 9 a.m., on a weekday with occupied dwelling units as the independent variable. Figures 6.7-6.9 present vehicle trips for general urban/suburban, dense multi-use urban, and center city core settings, respectively. Figures 6.10-6.12 include three person-based data plots for the three same settings.

The three data plots for person trips demonstrate approximately the same weighted average person trip rate, for this time period, across all three settings. The person trip rates are 0.53, 0.52, and 0.54 for the general urban/suburban, dense multi-use urban, and center city core settings, respectively. In the more urban settings, there is greater potential for non-vehicle trips in the form of walking, biking, or riding transit. The vehicle trip rates are 0.42, 0.28, and 0.30 for the general urban/suburban, dense multi-use urban, and center city core settings, respectively. As expected, the vehicle trip rates are lower for the more urban settings.

Figure 6.1 General Office Building (710)

Vehicle Trip Ends vs: 1000 Sq. Ft. GFA
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: General Urban/Suburban
 Number of Studies: 35
 Avg. Num. of 1000 Sq. Ft. GFA: 117
 Directional Distribution: 86% entering, 14% exiting

Vehicle Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
1.16	0.37 - 4.23	0.47

Data Plot and Equation

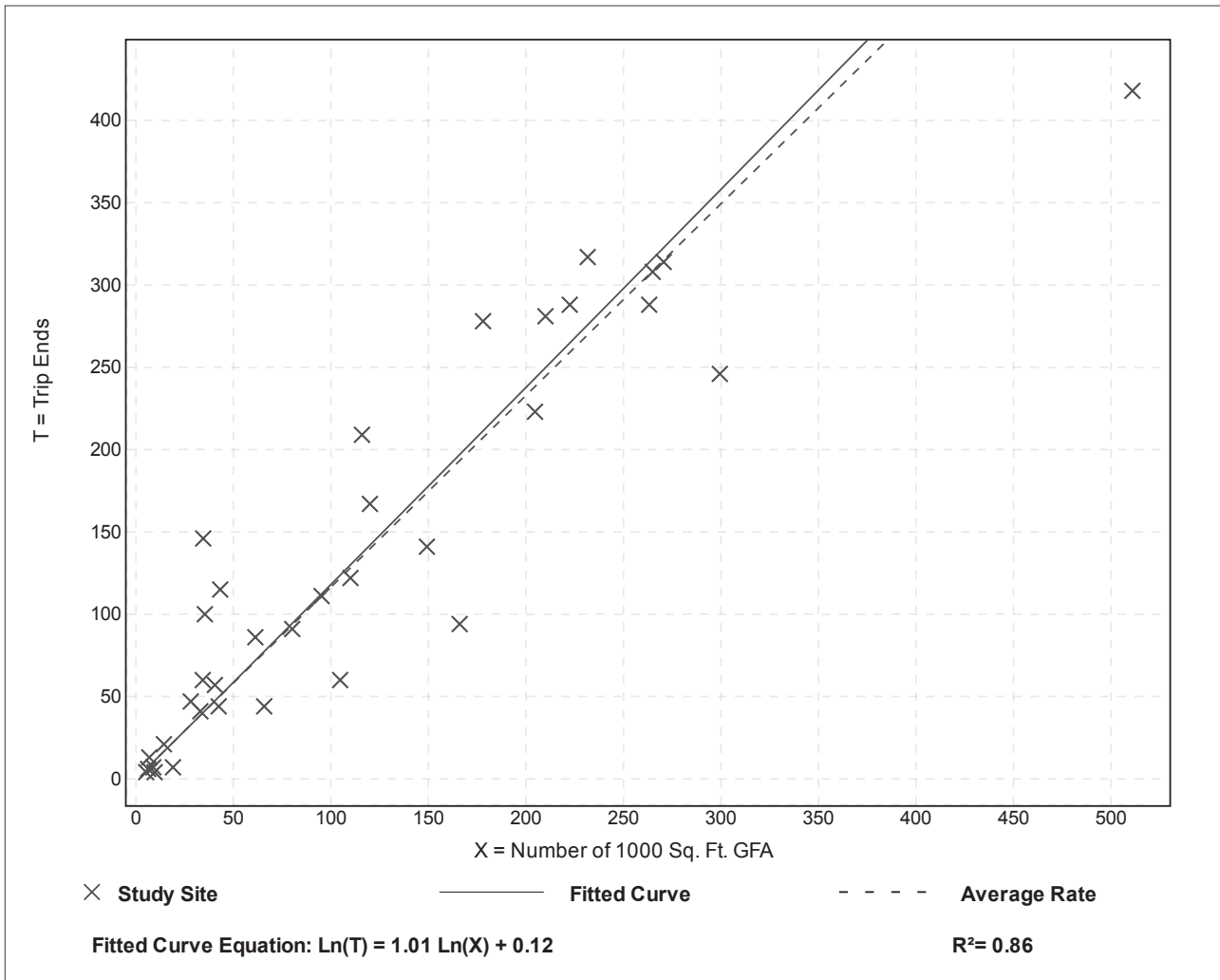


Figure 6.2 General Office Building (710)

Vehicle Trip Ends vs: 1000 Sq. Ft. GFA
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: Dense Multi-Use Urban

Number of Studies: 18
 Avg. Num. of 1000 Sq. Ft. GFA: 213
 Directional Distribution: 86% entering, 14% exiting

Vehicle Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
0.82	0.22 - 1.84	0.27

Data Plot and Equation

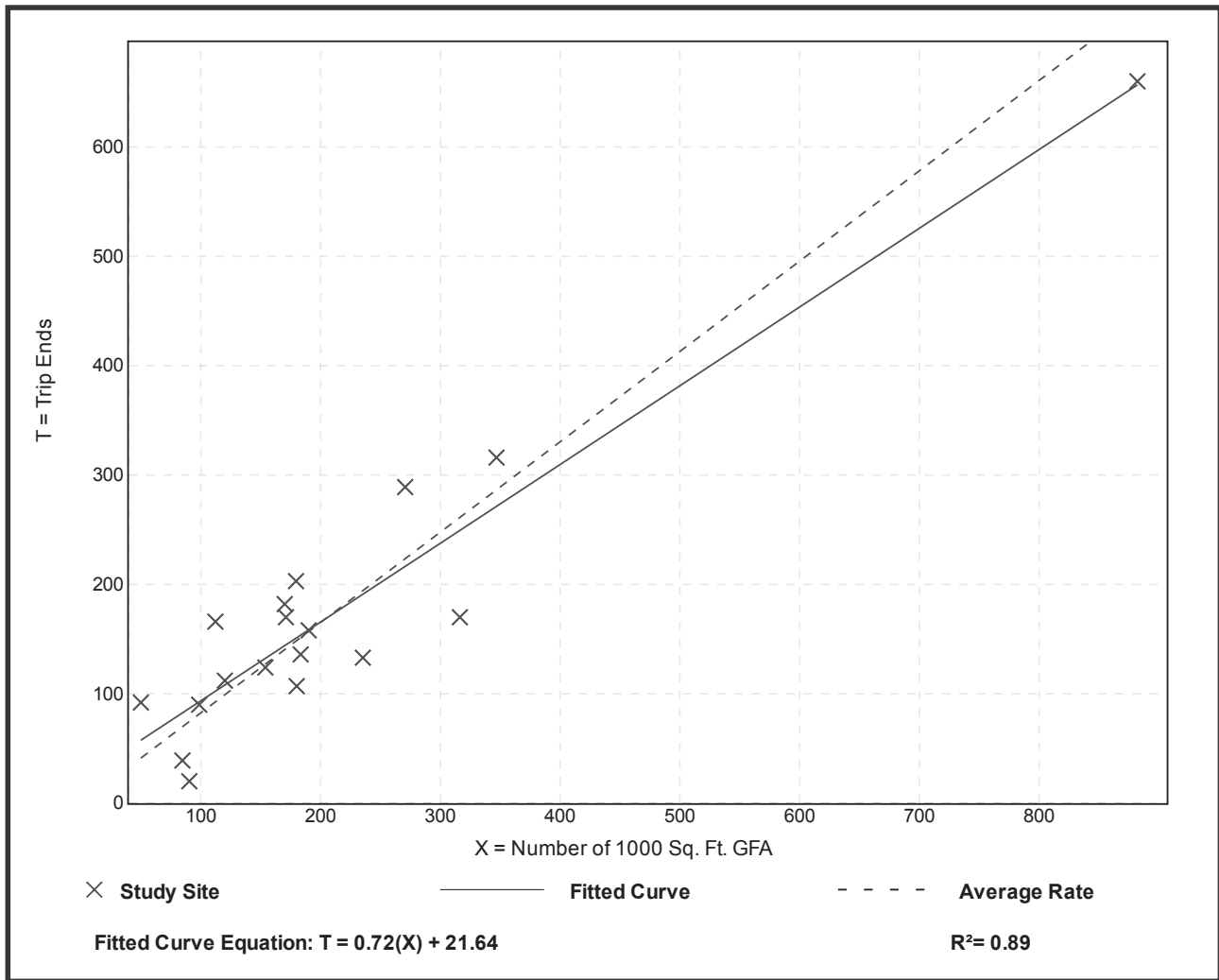


Figure 6.3 General Office Building (710)

Vehicle Trip Ends vs: 1000 Sq. Ft. GFA
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: Center City Core
 Number of Studies: 8
 Avg. Num. of 1000 Sq. Ft. GFA: 230
 Directional Distribution: Not Available

Vehicle Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
0.50	0.18 - 0.77	0.22

Data Plot and Equation

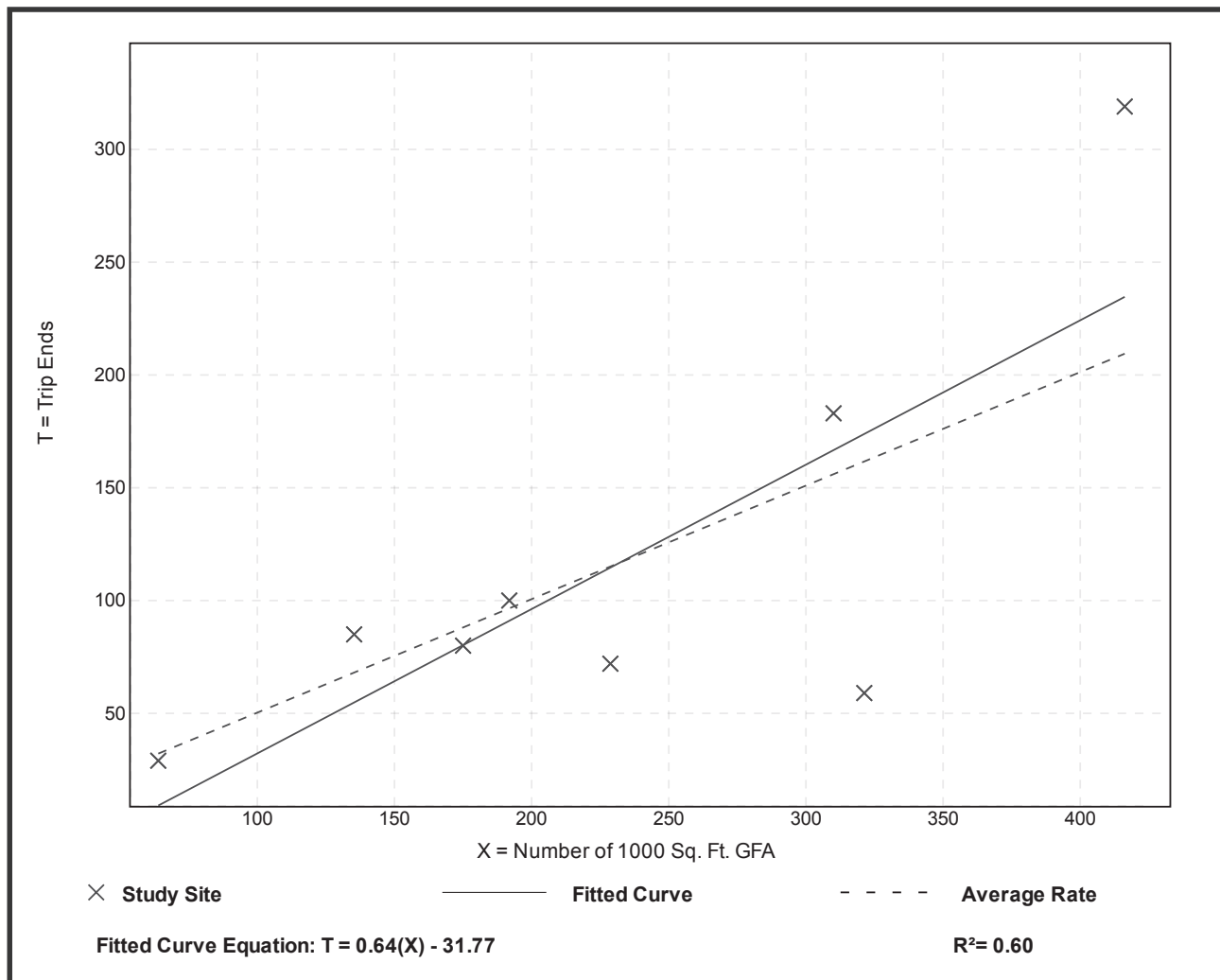


Figure 6.4 General Office Building (710)

Person Trip Ends vs: 1000 Sq. Ft. GFA
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: General Urban/Suburban
 Number of Studies: 18
 Avg. Num. of 1000 Sq. Ft. GFA: 177
 Directional Distribution: 87% entering, 13% exiting

Person Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
1.44	0.73 - 2.82	0.31

Data Plot and Equation

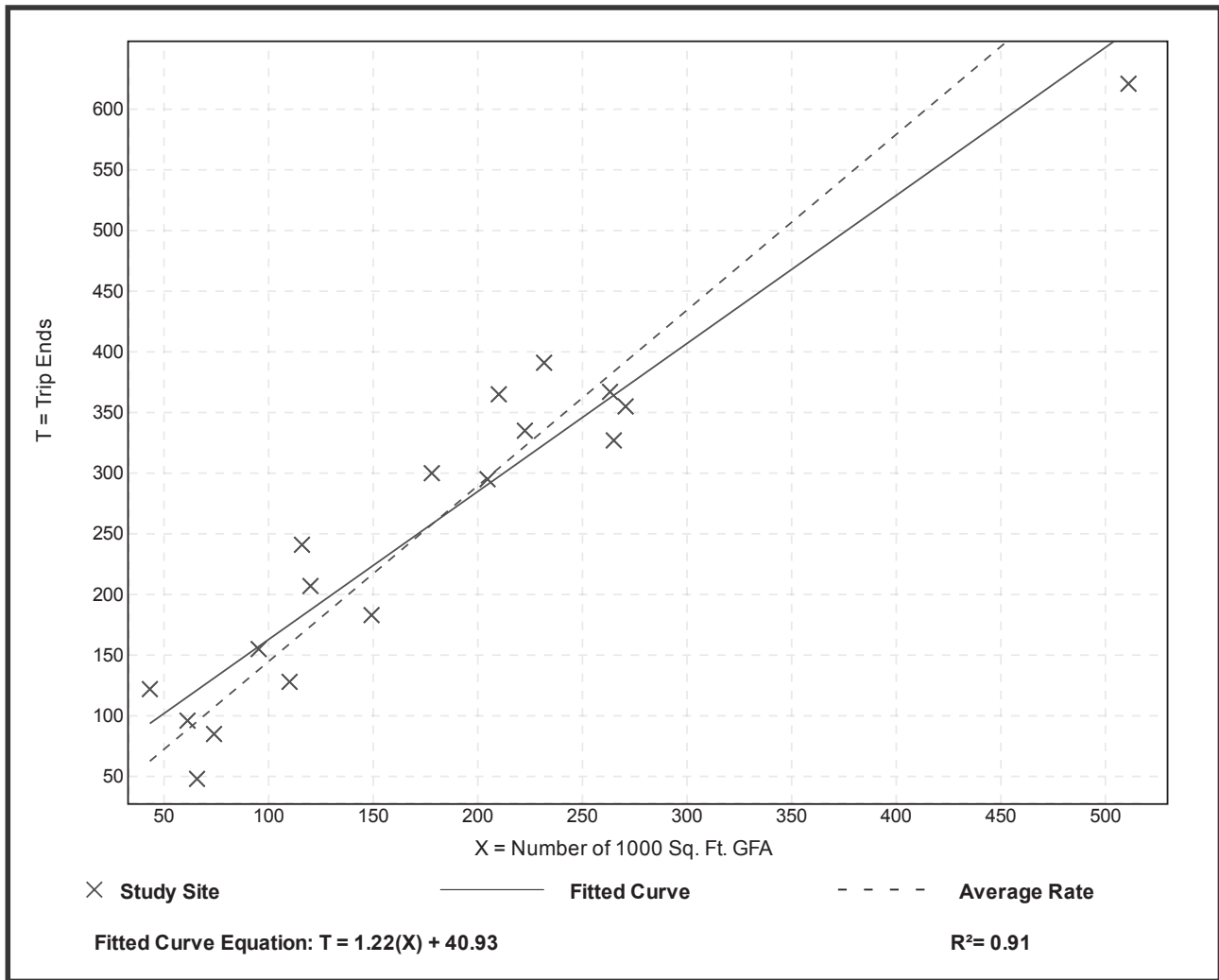


Figure 6.5 General Office Building (710)

Person Trip Ends vs: 1000 Sq. Ft. GFA
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: Dense Multi-Use Urban
 Number of Studies: 21
 Avg. Num. of 1000 Sq. Ft. GFA: 233
 Directional Distribution: 87% entering, 13% exiting

Person Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
1.25	0.3 - 2.02	0.36

Data Plot and Equation

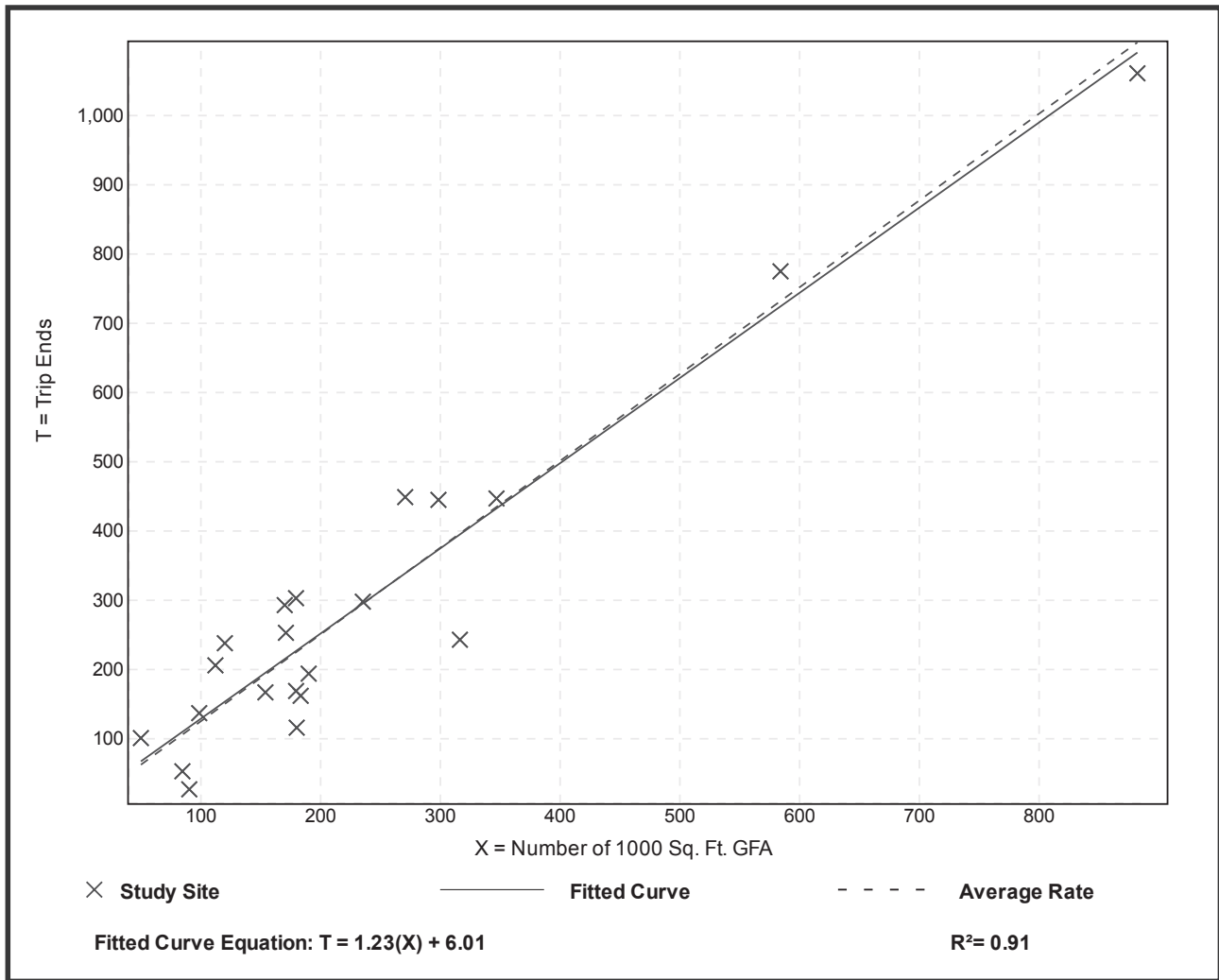


Figure 6.6

General Office Building (710)

Person Trip Ends vs: 1000 Sq. Ft. GFA
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: Center City Core

Number of Studies: 13
 Avg. Num. of 1000 Sq. Ft. GFA: 267
 Directional Distribution: 87% entering, 13% exiting

Person Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
1.24	0.63 - 1.95	0.37

Data Plot and Equation

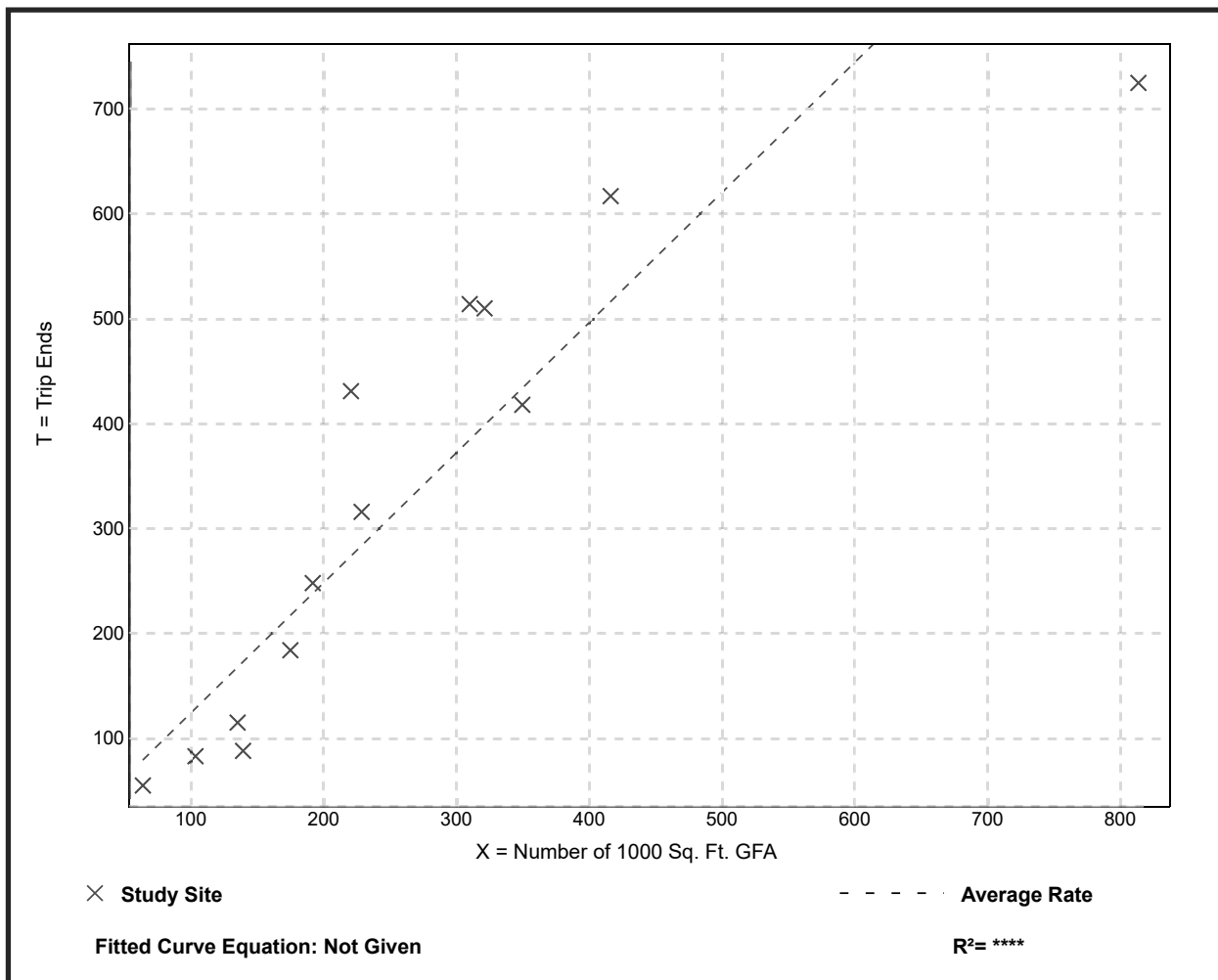


Figure 6.7 Multifamily Housing (Mid-Rise) (221)

Vehicle Trip Ends vs: Occupied Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: General Urban/Suburban
 Number of Studies: 7
 Avg. Num. of Occupied Dwelling Units: 234
 Directional Distribution: 26% entering, 74% exiting

Vehicle Trip Generation per Occupied Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.42	0.36 - 0.63	0.06

Data Plot and Equation

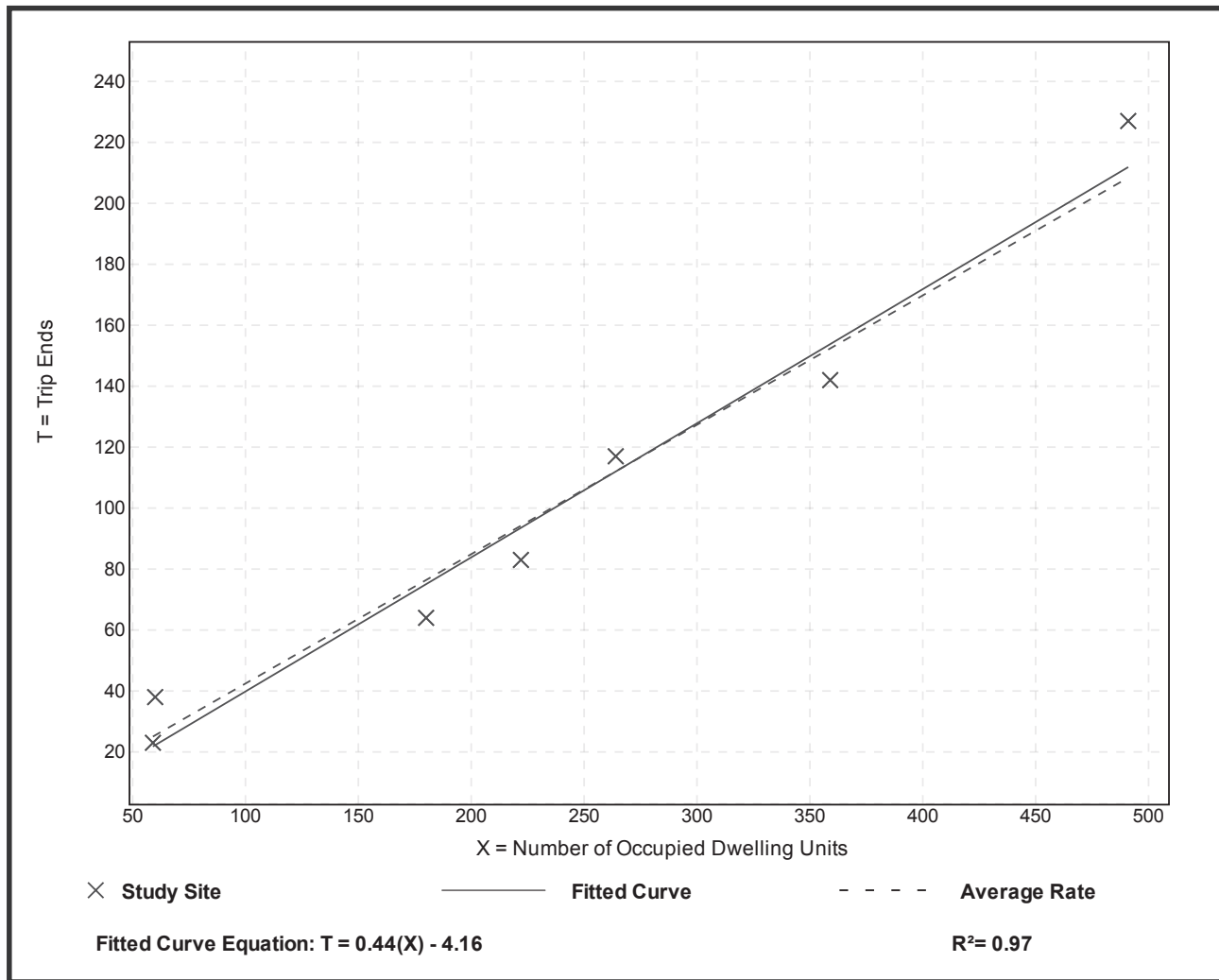


Figure 6.8 Multifamily Housing (Mid-Rise) (221)

Vehicle Trip Ends vs: Occupied Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: Dense Multi-Use Urban

Number of Studies: 32

Avg. Num. of Occupied Dwelling Units: 196

Directional Distribution: 27% entering, 73% exiting

Vehicle Trip Generation per Occupied Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.28	0.03 - 1.1	0.12

Data Plot and Equation

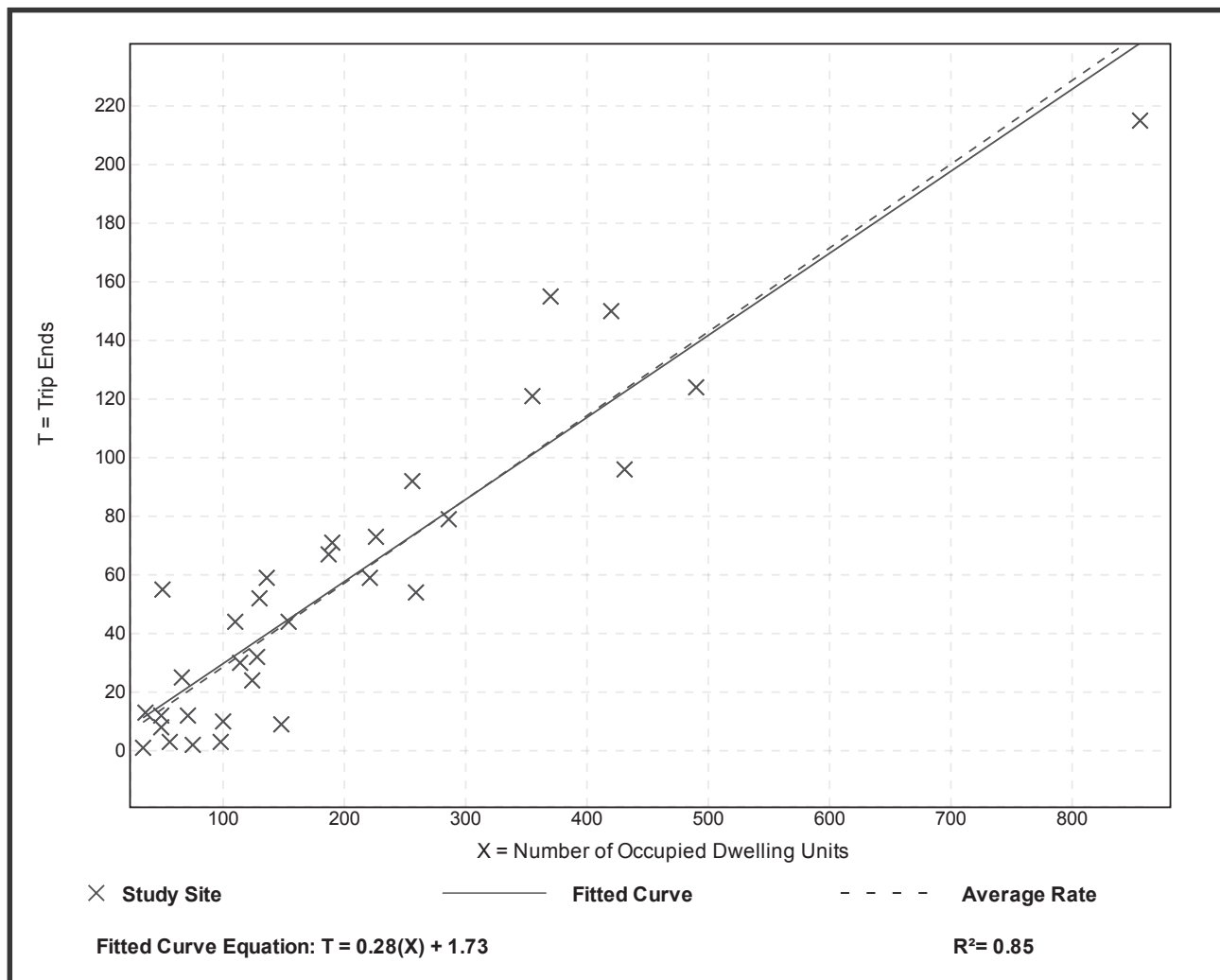


Figure 6.9 Multifamily Housing (Mid-Rise) (221)

Vehicle Trip Ends vs: Occupied Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.
Setting/Location: Center City Core
 Number of Studies: 8
 Avg. Num. of Occupied Dwelling Units: 116
 Directional Distribution: 31% entering, 69% exiting

Vehicle Trip Generation per Occupied Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.30	0.21 - 0.62	0.08

Data Plot and Equation

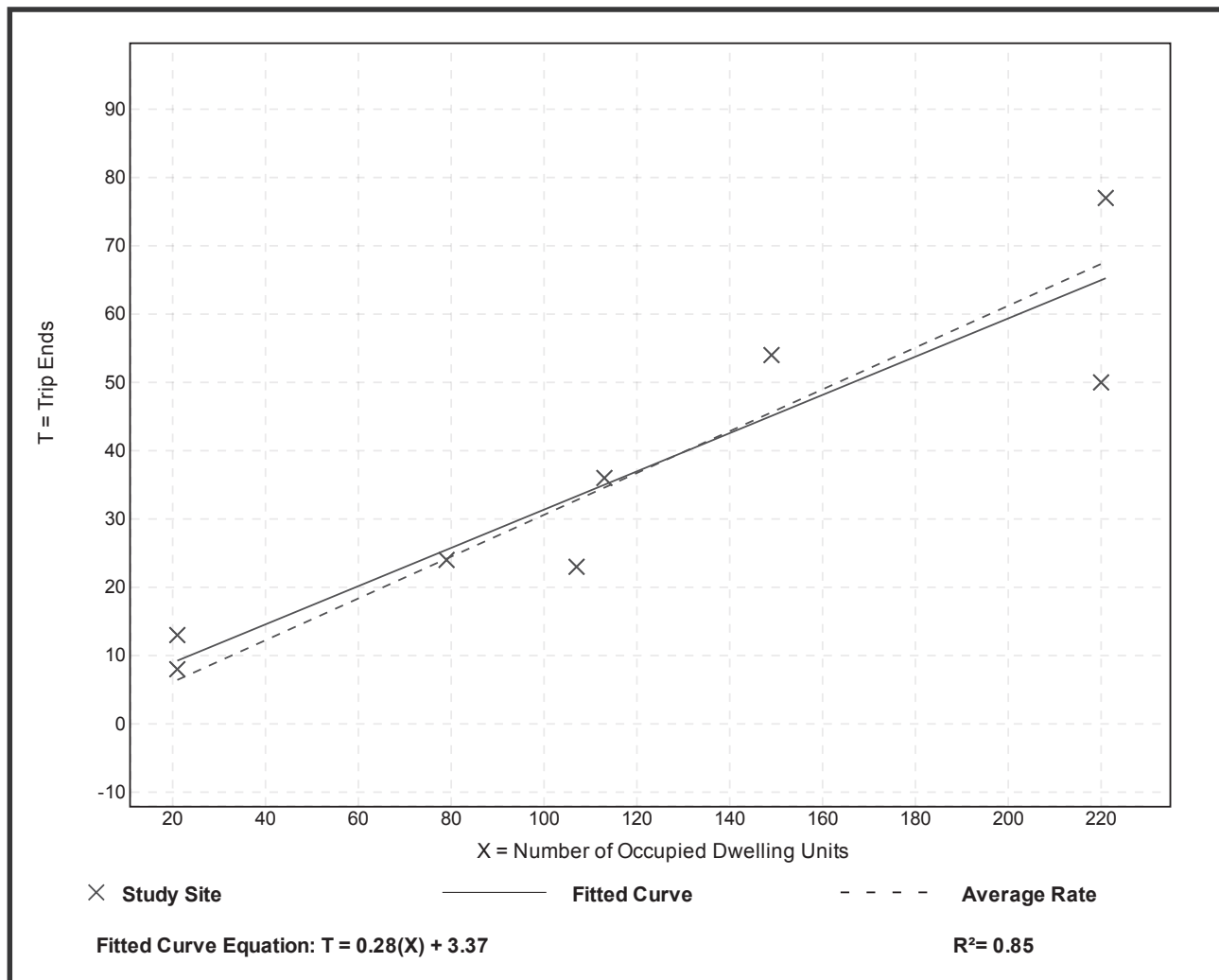


Figure 6.10 Multifamily Housing (Mid-Rise) (221)

Person Trip Ends vs: Occupied Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: General Urban/Suburban

Number of Studies: 3

Avg. Num. of Occupied Dwelling Units: 312

Directional Distribution: 21% entering, 79% exiting

Person Trip Generation per Occupied Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.53	0.48 - 0.58	0.64

Data Plot and Equation

Caution – Small Sample Size

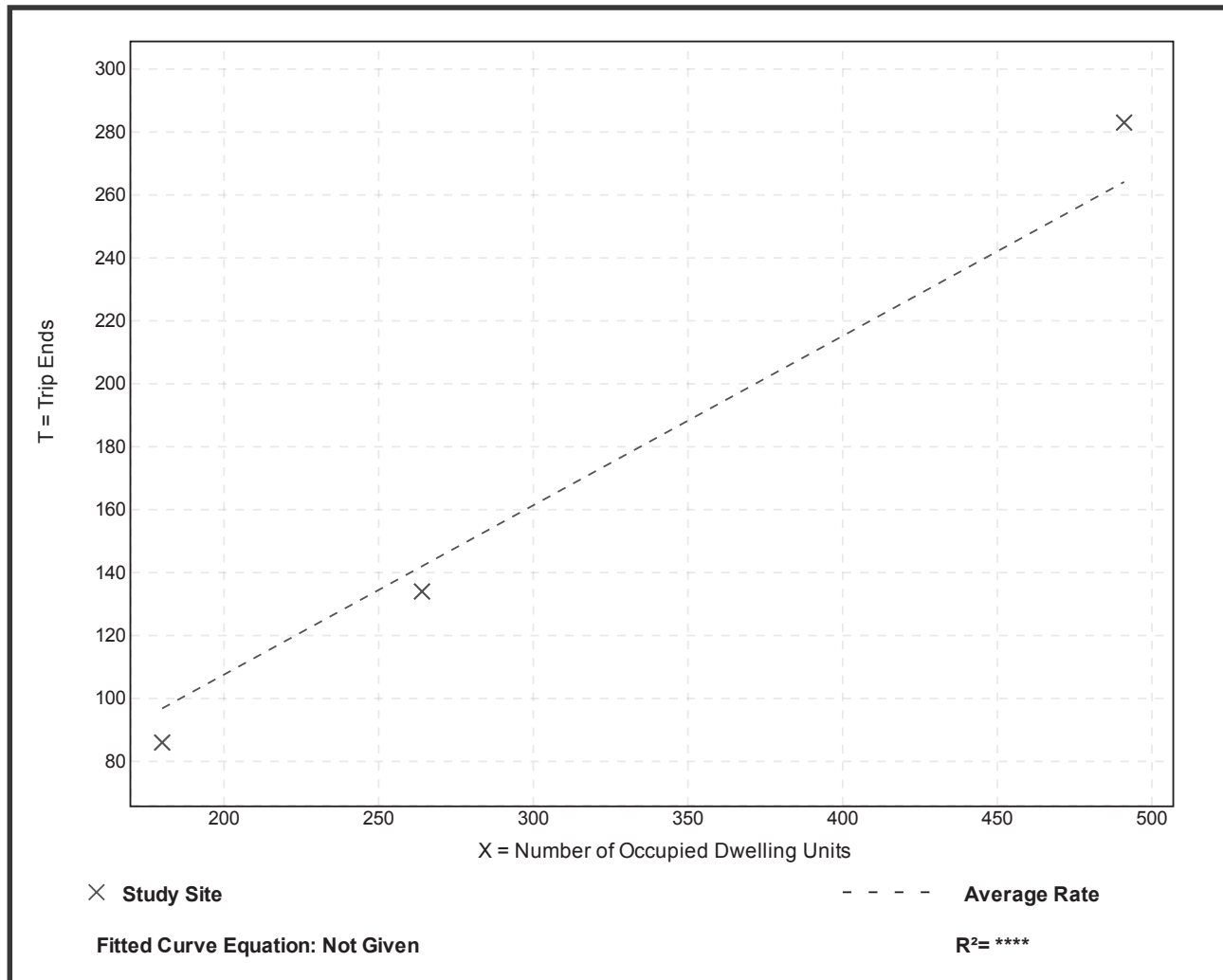


Figure 6.11

Multifamily Housing (Mid-Rise) (221)

Person Trip Ends vs: Occupied Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: Dense Multi-Use Urban

Number of Studies: 29

Avg. Num. of Occupied Dwelling Units: 212

Directional Distribution: 21% entering, 79% exiting

Person Trip Generation per Occupied Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.52	0.07 - 0.84	0.16

Data Plot and Equation

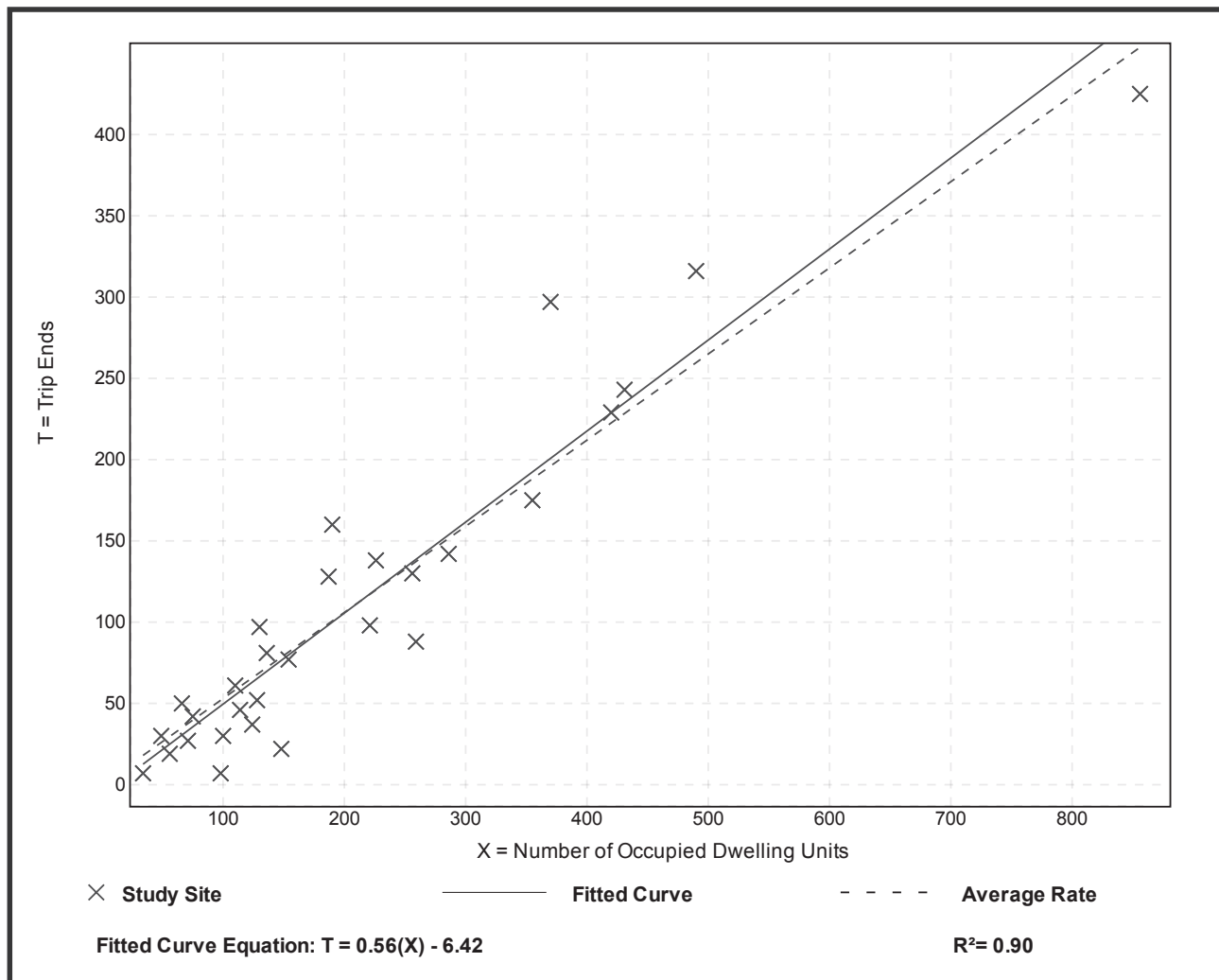


Figure 6.12 Multifamily Housing (Mid-Rise) (221)

Person Trip Ends vs: Occupied Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: Center City Core

Number of Studies: 5

Avg. Num. of Occupied Dwelling Units: 162

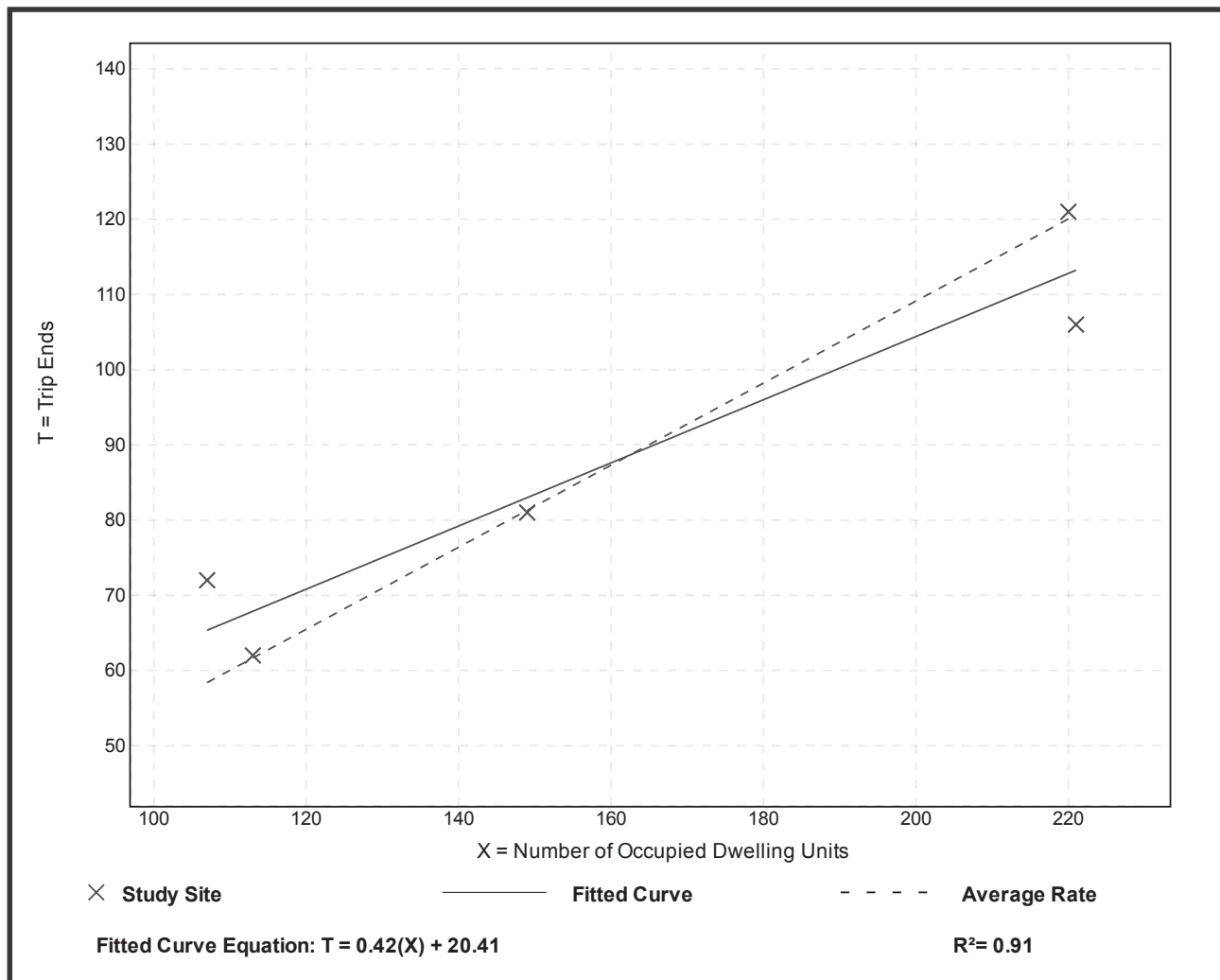
Directional Distribution: 24% entering, 76% exiting

Person Trip Generation per Occupied Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.54	0.48 - 0.67	0.06

Data Plot and Equation

Caution – Small Sample Size



7 | Instructions

The *Trip Generation Manual* provides the user community with three methods of estimating trips at proposed developments:

1. A plot of trip ends versus size of the independent variable for each study, which can be used to graphically obtain a rough estimate of trips;
2. The weighted average trip generation rate (number of weighted trip ends per unit of the independent variable); and
3. A regression equation, relating trip ends to the size of the independent variable.

Understanding the Methodologies

Selecting an appropriate method for estimating trips requires the use of engineering judgment and a thorough understanding of the three methodologies listed above. The methodologies are briefly explained in the following sections. A more detailed explanation of selecting the most reasonable method of estimating trips can be found in Chapter 4, “*Trip Generation Manual Data*,” of the *Trip Generation Handbook*, 3rd Edition.

Graphic Plot

The most fundamental display of available information is a plot of the total trip ends versus a related independent variable. This plot can be used to predict the number of trip ends generated for a given independent variable based on the existing data points. This method is reasonably accurate if there are sufficient data points within the range of the independent variable being used to define a relationship between the two variables. Otherwise, the need for interpreting the data (for example, discarding “erratic” data points) and for interpolating between data points may result in inconsistent interpretations of the data.

Weighted Average Trip Rate

The traditional method of forecasting trips has been to apply a weighted average trip rate. For example, the number of trips can be estimated by multiplying the number of trip ends per unit of independent variable by the number of units of the independent variable associated with the proposed development.

The standard deviation provides a measure of how widely dispersed the data points are around the calculated average; the less the dispersion (the lower the number), the better the approximation. The approximated standard deviations are provided for plots with three or more data points. Graphically, use of the weighted average rate assumes a linear relationship passing through the origin with a slope equal to the rate.

Regression Equation

Regression analysis provides a tool for developing an equation that defines the line that “fits best” through the data points.

Use of the regression equation allows a direct forecasting of trip ends based on the independent variable of the proposed development, thus eliminating differences of opinion arising from interpolating a plot of individual data points. Unlike the weighted average rate, the plotted equation does not necessarily pass through the origin, nor does the relationship have to be linear.

The correlation coefficient (R) is a measure of the degree of association or closeness between variables. The coefficient of determination (R^2) is the percent of the variance in the number of trips associated with the variance in the size of the independent variable. Thus, an R value of 0.8 results in an R^2 of 0.64, which is to say that 64 percent of the variance in the number of trips is accounted for by the variance in the size of the independent variable. The closer the R^2 value is to 1.0, the better the relationship between the number of trips and the size of the independent variable.

Sample Problem

The method of calculating trip generation through the use of either a regression equation or the weighted average trip generation rate is illustrated by the sample problem below.

For an intermodal truck terminal (Land Use 030) with 25,000 sq. ft. GFA, the calculation of vehicle trip ends on an average weekday during the peak hour of adjacent street traffic between 4 and 6 p.m. is provided as follows. Refer to the data and plot presented for this land use in Figure 5.1, “Sample Data Page,” shown in Chapter 5. The rate and equation are listed accordingly:

Rate: $T = 1.86$ trip ends per 1,000 sq. ft. GFA

Equation: $T = 0.22(X) + 35.12$

Calculate vehicle trip ends using the rate:

$$T = 1.86 \times 25 = 46 \text{ vehicle trip ends}$$

Calculate vehicle trip ends using the equation:

$$T = 0.22(25) + 35.12 = 41 \text{ vehicle trip ends}$$

Choice of Day and Time Period

The day and time period that should be used in determining the appropriate design requirements for the proposed development are directly related to the type of land use and the traffic characteristics on the adjacent street system. Trip generation for different days and time periods should be examined to determine when the site being planned experiences its peak traffic flow and to define the relationship between the site’s peak generation and the peaking characteristics of the adjacent street system.

In most cases, the traffic volume generated by the site combined with the traffic volume already on its adjacent street is highest during the traditional commuting peak hours. Thus, the maximum impact would be evaluated by adding the generator peak traffic volume and the adjacent street peak traffic volume.

Some land uses, however, do not peak at the same time as the adjacent streets. Therefore, combinations of site volumes and street volumes at different times should be checked to determine the proposed site's maximum impact.

More detailed information than is included in this document may be required to determine the peak time and volumes needed for the analysis.

8 | Update Procedure

ITE has established a procedure for updating the data summarized in this manual and invites all interested parties to collect data from one or more sites and submit the data to ITE Headquarters.

This procedure will result in a continual, uniform method of obtaining and summarizing the current trip generation data for all land uses. ITE will do the following:

- Store all trip generation data.
- Encourage ITE district and section technical committees, ITE student chapters, governmental agencies, and private consultants to collect additional data.
- Distribute trip generation data forms in hard copy and electronic formats.
- Maintain a database for trip generation analyses and summarization.
- Maintain and modify when necessary a uniform procedure for collecting data.
- Summarize trip generation data.
- Conduct special trip generation analyses when appropriate.
- Revise trip generation rates, equations, plots and text on the basis of additional data.
- Identify data collection needs in areas where deficiencies exist or where little information is available.

A new electronic data collection system has been developed to facilitate an improved process for submitting data to ITE to be considered for inclusion in the *Trip Generation Manual*. The new online data collection site is available at www.itedatasubmission.org. Hard copy Trip Generation data collection forms are also available on the ITE website at: <http://www.ite.org/tripgeneration>. Data may also be submitted through direct transmittal of electronic files to the ITE Trip Generation email address presented below.

Completed forms should be returned to ITE at the following address:

Institute of Transportation Engineers
1627 Eye Street, NW, Suite 600
Washington, DC 20006
Telephone: +1 202-785-0060
Fax: +1 202-785-0609
www.ite.org
email: tripgen@ite.org

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