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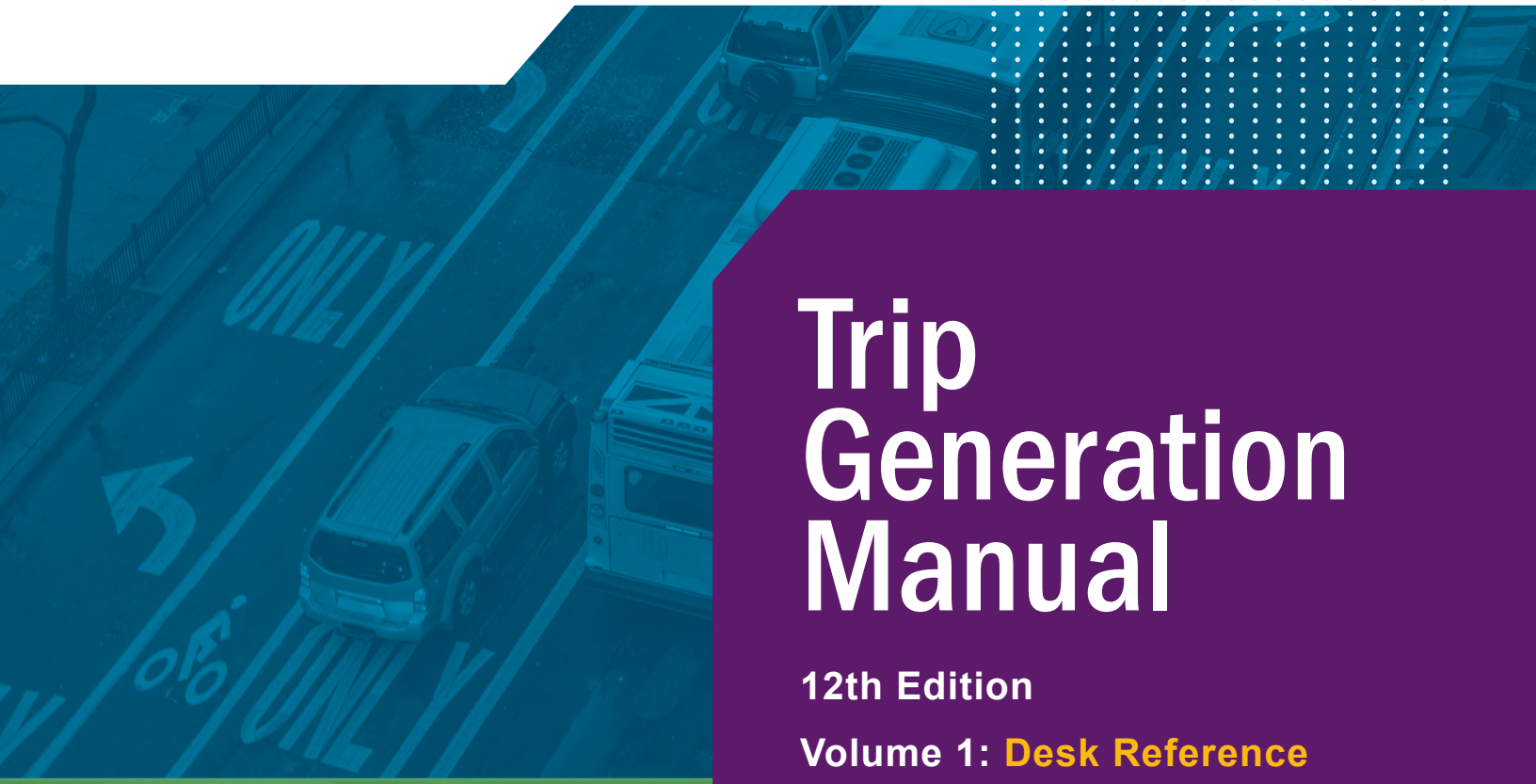

Trip Generation Manual

12th Edition

Volume 1: Desk Reference

August 2025

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Preface

Trip Generation Manual, 12th Edition (TGM), is a publication of ITE—A Community of Transportation Professionals (ITE). TGM is an educational tool for planners, transportation professionals, zoning boards, and others who are interested in estimating trip generation at a proposed development.

The hard-copy volumes of the TGM include the most frequently used combinations of land uses, time periods, independent variables, modes, and settings, including land use descriptions and data plots. Data contained in TGM are presented for informational purposes only and do not include ITE recommendations regarding the best course of action or the preferred application of the data. The information is based on trip generation studies submitted voluntarily to ITE by public agencies, developers, consulting firms, student chapters, and associations.

TGM is also available via the ITETripGen web app, which may be purchased with the hard-copy volumes or as a standalone web app license. This online software allows electronic access to the entire trip generation dataset, with numerous filtering capabilities including site setting (i.e., rural, general urban/suburban, dense multi-use urban, center city core), geographic location, age of data, and development size. The ITETripGen web app also provides access to pass-by trip data, time-of-day distributions, modal plots for all land uses, and truck trip generation data. Instructions for using ITETripGen are included within the app.

Additional data are needed from the profession to create a data-rich environment for trip generation analysis. ITE will continue to prepare updates to TGM.

User comments on TGM are invited. ITE continually seeks ways to increase the value of this resource and requests that users provide recently collected data for the land uses presented in TGM—or any other land uses—for inclusion in future editions and updates.

Although this report provides a powerful tool to better understand site-generated vehicle and person trips, it contains information that can be easily misinterpreted without sound professional judgment. Users are cautioned to use professional judgment in applying all data contained in this report. They also need to be cognizant of site and area characteristics that can affect trip generation (e.g., availability of transit services, demand management strategies, parking pricing), and of the continued need for additional data. Lack of appreciation for these factors may lead to an inaccurate estimate of vehicle and person trip generation, and ultimately to the improper design of vehicle and person site access.

Acknowledgments

Trip Generation Manual, 12th Edition, is the result of a concerted effort by dedicated volunteers, contractors, 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 Advisory Group members, whose dedicated service, expertise, and insight contributed immensely to the completion of this resource.

Kyla Elzinga (M), ITE Technical Programs Manager and Luana Broshears (M), ITE Planning and Safety Senior Director served as the technical leads for the project and were responsible for assembling and analyzing all data received, conducting statistical analyses and validation, and composing new text to define new or refined land uses for the 12th Edition.

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

ITE Communications Senior Director Bridget G. Wendling edited and managed the production of the publication.

Blue House Design Company provided production services for this publication.

Special thanks are extended to Transoft Solutions for providing programming support that enabled modifications to the existing ITETripGen web app.

Sincere appreciation is also extended to Imperial Traffic & Data Collection for assisting ITE in exploring a new approach to trip generation data collection and for contributing a significant amount of data to this update.

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

The following members of the Trip Generation Review Panel provided technical guidance and review of this publication content:

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(Letters in parentheses indicate ITE member grade: M – Member; F – Fellow)

1 Introduction

Trip Generation Basics

Trip generation is one measure of travel behavior. It is based on the notion that people regularly travel to or from a particular land use and location, and that the amount and type of activity at the location—whether retail, office, residential, or service-oriented—uniquely determine the amount, type, and mode of that travel. The calculation of the number of trips entering or exiting different kinds of land uses forms the foundation of trip generation estimation. The basic premise upon which all trip generation estimates are based is that the number of trips entering and exiting two development sites with the same land use, size, and setting will be comparable.

As an illustration of trip generation, consider that people leave their homes every day to travel to work, go shopping, go to school, visit friends, or attend appointments. Each departure from the home is considered a trip. Each return to the home is likewise considered a trip. If a cordon is placed around the residence to record the comings and goings over a 24-hour period, the number of trips the dwelling unit generates per day can be determined. If four trips leave the home—for instance, one to work, one to school, one to shop, and one to the dentist—and these same four trips return to the home on the same day, the dwelling unit has a trip generation rate, for that particular day, of eight trips per day (four outbound and four inbound). If additional trips are made to or from that dwelling unit by visitors, by delivery vehicles, or other service personnel, these trips would also be considered trips generated by the residence.

Similarly, travel to and from any type of location can be counted. Each specific type of establishment—a factory, a store, an office building, or an entire shopping center—is considered a trip generator.

As noted above, the fundamental measurement for trip generation is trips. In technical terms, a trip has an origin and a destination at its two 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 (inbound) and exiting (outbound) a site. An entering trip end is a destination trip end; an exiting trip end is an origin trip end.

Uses of Trip Generation Data

The basic product of the procedures in the *Trip Generation Manual* (TGM) is an estimate of the inbound and outbound trips by mode (vehicle, person, truck, transit, bicycle, pedestrian) for a study site. These trip generation estimates are used for a variety of functions, such as:

- Determining site access and circulation requirements for a study site;
- Estimating future traffic volumes upon which off-site transportation improvements are based;
- Determining fees for use in addressing potential impacts to the transportation systems; or
- Evaluating the implications of requests for potential zoning or land use changes.

In some cases, the modal trip generation estimates can be used for purposes beyond trip generation, such as to assess parking demand, forecast regional travel for special generators, or estimate vehicular emissions or other environmental measures.

Trip Generation Manual

Purpose

The purpose of the *Trip Generation Manual* (TGM) is to present a summary of trip generation data that have been voluntarily collected and submitted to ITE. This manual represents the 12th edition and incorporates data from the previous 11 editions and various supplements. As additional trip generation data become available, they will be distributed through periodic updates of this resource.

The *Trip Generation Manual* contains text, tables, data plots, and statistics that describe the current state-of-the-practice understanding of the relationship between pedestrian, bicycle, transit, motor vehicle, and truck trip generation and characteristics associated with an individual development site or land use. The manual presents land use descriptions and data plots for combinations of available land uses, time periods, independent variables, modes, and settings contained in the ITE database.

Data contained in TGM are presented for informational purposes. Guidance on the proper interpretation and application of trip generation data is provided in the ITE Recommended Practice, *Trip Generation Handbook*. More information on relevant Handbook items is contained in Chapter 8 “Approaches for Estimating Trip Generation.”

Format

The hard-copy volumes of TGM include the most frequently used combinations of land uses, time periods, independent variables, modes, and settings, including land use descriptions and data plots.

ITETripGen web app provides electronic access to all TGM content, including all statistics, data plots, and land use descriptions. The app also provides access to pass-by trip data, time-of-day distributions, modal plots for all land uses, truck trip generation data, and the *Trip Generation Handbook*, an ITE Recommended Practice on how to use TGM.

Organization

The *Trip Generation Manual*, 12th Edition, hard copy is organized in five volumes. Volume 1 is the Desk Reference and contains Chapters 1 through 10. In addition to this Chapter, Volume 1 contains:

- **Chapter 2** presents a discussion of the emerging trends in trip generation.
- **Chapter 3** presents a summary of the changes in the 12th Edition relative to the 11th Edition.
- **Chapter 4** provides a glossary of terms used in the 12th Edition. Definitions are presented for trip types and modes, various settings used to classify study site locations, time periods for which trip generation is reported, and independent variables for which a relationship to trip generation is plotted. Terms used on the land use description pages and in the data plots are also defined in Chapter 4.
- **Chapter 5** describes the ITE trip generation database. The data included in the 12th Edition were voluntarily collected and submitted to ITE by public agencies, developers, consulting firms, student chapters, and associations. The data represent person (either total or by travel mode) and vehicle (either total or by vehicle classification) trip generation studies for which at least one hour of counts were conducted on a given day.

- **Chapter 6** describes the generic contents of the trip generation data plots and their associated statistics. It also offers guidance on understanding the data presented in the manual.
- **Chapter 7** presents instructions for reading the data plots and includes a sample problem and solution using 12th Edition data plots.
- **Chapter 8** provides important supplemental information on the contents of the *ITE Trip Generation Handbook*, an ITE Recommended Practice that provides guidance on how to use and interpret the data in TGM.
- **Chapter 9** presents ITE's procedure for updating the trip generation database and associated data plots and statistics.
- **Chapter 10** lists the sources for all data presented in the 12th Edition.

Volumes 2 through 5 present data plots organized by land use and site setting:

- **Volume 2** includes the land use descriptions and data plots for all land uses with urban data, including dense multi-use urban and center city core areas.
- **Volumes 3 through 5** include land use descriptions and data plots for all land uses with general urban/suburban and rural data.

The technical appendices in the 12th Edition provide pass-by trip percentages, time-of-day distributions, modal plots for all land uses, and truck trip generation data. The appendices are accessible through the ITETripGen web app.

Land Use Descriptions and Trip Generation Data Plots

Each land use code begins with one or more pages of text describing the characteristics of the development sites in the land use. These are followed by one or more pages of data plots and associated statistics.

Under the heading **Land Use Description**, a summary description is provided for the sites where the data were collected.

The section under the heading **Additional Data** may include the following information:

- The decades during which the data were collected
- The states/provinces for the study sites
- Any cautionary notes for application of the data

The section under the heading **Sources** lists source numbers that comprise the database for the land use. Chapter 10 provides a source name for each source number.

For all land use descriptions—regardless of setting—the listings for decades, states/provinces, and sources represent the full database for that land use and subcategory.

2 Trip Generation Emerging Trends

The COVID-19 pandemic significantly impacted daily travel in North America, and although trip patterns have not fully settled into a consistent post-pandemic routine, several notable trends have emerged. While trip generation data are continually collected, not enough time has passed since the height of the pandemic to fully reflect changes in trip generation rates in the *Trip Generation Manual* (TGM). Nevertheless, ITE and a group of industry experts have identified emerging trends that may ultimately influence TGM. This chapter provides information on trends to consider when developing trip generation estimates for proposed developments.

Several data plots and statistics presented in the TGM are based on data collected prior to the pandemic. ITE recognizes that some TGM data plots and statistics may need to be updated in the future. However, it remains unclear which data plots and statistics will be affected until new study site data are collected and analyzed. ITE has identified several land uses for which measurable changes in trip generation characteristics may occur.

ITE is actively exploring emerging trends in trip generation, particularly as travel behavior continues to evolve in the years following the pandemic. To capture potential shifts in trip patterns, practitioners are encouraged to continue collecting and submitting updated data for the land uses described in this chapter. This is especially important given the regular removal of older data from TGM, which significantly reduces the dataset available for many of ITE's most widely used land uses.

Industrial (100s)

Industry experts note that the increased reliance on e-commerce and delivery services may result in more trips to and from high-cube warehouses and related facilities. Whether this increased demand is met through additional trips at current sites, an increase in the number of facilities, or some combination thereof, remains to be seen.

Residential (200s)

Residential trip generation patterns have shifted in recent years, but how they have changed may vary based on the development type and location. Two major drivers of change are the rise of e-commerce and the widespread adoption of hybrid or remote work. E-commerce effects are challenging to quantify, particularly given the limited amount of data shared by e-commerce companies. For example, one delivery driver serves multiple homes in one neighborhood on a single trip, but deliveries to those homes may occur on multiple days each week or through multiple deliveries on the same day. Delivery trips are also likely to occur throughout the day and week, unlike trips to physical stores, which may be more concentrated at certain times.

Research indicates that telecommuting has altered daily travel. A post-pandemic study found that employees with longer commutes, higher incomes, and higher education levels are more likely to continue telecommuting[1].

---

[1] Mohammadi, M. (Yalda), Rahimi, E., Davatgari, A., Javadinasr, M., Mohammadian, A. (Kouros), Bhagat-Conway, M. W., Salon, D., Derrible, S., Pendyala, R., and Khoeini, S. (2022). *Examining the persistence of telecommuting after the COVID-19 pandemic. Transportation Letters*, 15(6), 608–621. https://doi.org/10.1080/19427867.2022.2077582

As a result, traditional AM/PM peak commuting patterns may shift. It has also been reported that telework has led to an increase in home-based trips throughout the day (e.g., errands, picking up lunch, etc.) resulting in time-of-day impacts in and near residential developments.

Location and household composition also play roles. For example, there has been an increase in developments on the periphery of metropolitan regions, such as large, master-planned "bedroom communities," which may have trip generation rates significantly lower than those of developments located nearer to employment and services. For instance, large residential developments on the outskirts of Tucson, Arizona, have shown daily and peak-hour trip rates more than 30% below TGM averages[2]. Conversely, some areas have experienced an increase in multi-generational households, which may generate more trips, especially if multiple adults work outside the home.

Lastly, the increasing prevalence of short-term rental properties may also affect trip generation, particularly if multiple units are purchased solely for this purpose. These effects are hard to measure, particularly since many short-term rentals are in developments which prohibit them.

Recreational (400s)

During the height of the pandemic, outdoor recreational trips surged, while indoor gym trips declined. Fitness centers have since rebounded, alongside new recreational formats such as boutique fitness studios, axe throwing, golf entertainment complexes, and pickleball courts. While TGM includes data for some of these emerging land uses, transportation professionals should exercise caution when estimating trip generation for these specialized developments, as their characteristics continue to evolve rapidly.

Institutional (500s)

While not exclusively a pandemic impact, more elementary and middle school students are now traveling in personal vehicles instead of by school bus. This may be most pronounced in areas with private, charter, or school-choice options.

At the college level, the pandemic accelerated hybrid and virtual learning. Many colleges and universities already had virtual options, which were generally geared towards out-of-state students and/or those who were working on their education while maintaining a full-time job. While some students have returned to campus, others have remained fully online. At one Southern California two-year college, approximately 1/3 of students now attend virtually—up from less than 5 percent before the pandemic[3]. However, online students may still travel to campus occasionally.

Other travel impacts related to college campuses include shifts in mode choice and interactions with the surrounding areas. For instance, large campuses with substantial student housing may affect trips to nearby retailers and restaurants. This is explicitly captured in mixed-use trip generation models like EPA's Mixed-Use Development Trip Generation Tool (MXD)[4]. In addition, the increased prevalence of e-bikes and e-scooters (both rental and privately owned) may influence vehicular and/or walking trips, particularly on and near large college campuses.

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2 Psomas. (2022). *Rocking K South Transportation Infrastructure Master Plan*.

3 Psomas. (2024). *Parking Inventory and Evaluation for Mt. San Antonio College 2023–2024 School Year*.

4 U.S. Environmental Protection Agency. (n.d.) *Mixed-Use Trip Generation Model*. Retrieved from https://www.epa.gov/smartgrowth/mixed-use-trip-generation-model

Medical (600s)

The medical services landscape was evolving pre-pandemic due to an aging population and an increasing demand for telemedicine. The number of people in the United States who are over 65 is projected to exceed those under 18 years[5]. Recent acceleration of this trend can be attributed to reduced birth rates and improved medicine. While telehealth may reduce in-person visits, the scope of the reduction may not be substantial. Other trends in medical facilities include the growth in large medical campuses and shared medical offices.

Office (700s)

Office trip generation was among the most impacted during the COVID-19 pandemic, with widespread adoption of remote work. As work-from-home and hybrid schedules became the norm, many companies downsized their office spaces and/or began offering shared workspaces. More recently, however, a growing number of employers have required workers to return to the office for at least part of the week. Some companies and agencies have even reversed their once-permanent hybrid policies in favor of a full-time return to office model.

Therefore, although office trip generation decreased in the immediate aftermath of the COVID-19 pandemic, the change may not be permanent. Even under a hybrid policy, most offices are likely to have all or most employees in the office at least one day per week. As a result, while trip generation rates may be significantly lower on days when most staff work remotely, rates on in-office days remain largely consistent with current TGM data.

Retail (800s)

Though e-commerce was on the rise before the pandemic, it has since exploded in popularity. According to U.S. Department of Commerce data from March 2025[6], retail e-commerce sales were nearly 50% higher in 2024 than in 2019. This growth likely reduced trips to brick-and-mortar stores.

Still, impacts vary by retail type. Anecdotal evidence shows that discount stores have gained in-person customers—possibly due to inflation—and some are expanding to include groceries. Shopping malls are less busy overall but are thriving in relatively affluent areas where dining, drinking, entertainment, and residential uses are co-located. Some malls are repurposing space for other uses to remain viable.

Additionally, grassroots boycotts of specific retailers have affected traffic and revenue at certain stores, although the long-term impact remains to be seen.

Services (900s)

Alongside the growth of hybrid work and e-commerce, the pandemic accelerated the widespread adoption of drive-through, curbside, and delivery options for food purchases. Once concentrated in highly urbanized areas, food delivery services have become common even in suburban settings. Although a meal delivered rather than being picked up or eaten on-site does not change trip generation, the convenience of food delivery services may encourage people to dine out more frequently.

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[5] U.S. Census Bureau. (2019). Demographic Turning Points for the United States: Population Projections from 2020 to 2060.

[6] U.S. Census Bureau. (2025). *Quarterly Retail E-Commerce Sales*, Q4 2024. Retrieved from https://www.census.gov/retail/ecommerce.html

More notably in the shorter term, restaurant traffic at drive-throughs may have increased since the pandemic. Some restaurants that previously operated without drive-through service options have added them, which can lead to queue spillback within parking lots or onto adjacent roadways. Again, while the overall trips may remain stable, the expansion of carry-out and drive-through options (or post-pandemic continuation of such options) may shift inbound and outbound volumes during peak periods.

Other services likely significantly affected include banks, due to the rise of online banking, and large travel centers, which are being built as primary destinations.

Other Considerations

Newer mixed-use developments increasingly integrate residential, commercial, and industrial uses—sometimes beyond the original NCHRP methodology[7] developed in the 2010s to include residential, commercial, and industrial uses. Internal capture rates may also have changed. In addition, there are unintended consequences which may have been observed at mixed-use developments near transit; vehicle use within the site may be lower, but excess parking provides an opportunity for others to use the site as a park-and-ride.

Micromobility is expanding. Once limited to human-powered options, bike and scooter share systems now include e-bikes and e-scooters, extending the distance a person can travel and potentially replacing some vehicular trips.

Conclusion

The COVID-19 pandemic accelerated some lifestyle changes which were already underway and introduced new ones that were not anticipated. While some trends appear to be here to stay, many others are still in flux. The long-term “new normal” may take years to fully emerge.

During this period of adjustment, ITE recommends caution when applying historical TGM data to post-pandemic conditions. Whether these impacts represent lasting changes or fall within existing variability remains unknown.

When feasible, current local data can be used to supplement TGM data and support decisions on how to best estimate site-generated trips during this evolving period. ITE will continue to document changes for specific land uses based on actual counts and will replace historical data as needed. Users are encouraged to submit current counts when possible. ITE will regularly review and analyze submitted data and provide updated guidance as conditions warrant.

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[7] National Academies of Sciences, Engineering, and Medicine. (2011). *Enhancing Internal Trip Capture Estimation for Mixed-Use Developments*. Washington, DC: The National Academies Press. https://doi.org/10.17226/14489.

3 Changes Since the 11th Edition

The 12th Edition of the *Trip Generation Manual* (TGM) introduces several significant content updates compared to the 11th Edition. Nine new land use classifications and data from more than 550 sites have been added to the 12th Edition. The database was refined for relevance by removing all data prior to 1990. As in previous editions, the addition of new data, elimination of outdated data, and reexamination of existing data resulted in updates to land use codes, independent variables, and land use descriptions. These changes are summarized in this chapter.

The hard copy volumes of TGM contain the most frequently used combinations of land uses, time periods, independent variables, modes, and settings—including land use descriptions and data plots. The ITETripGen web app provides exclusive electronic access to all TGM content, including over 1,100 additional data plots for less frequently used modal data. A new feature in the web app allows users to view the collection date of each data point by hovering over the point within a plot.

Desk Reference Changes

The Desk Reference has been enhanced with three key additions:

- An expanded Chapter 1 on trip generation basics and usage.
- An expanded Chapter 2 on emerging trends.
- A new Chapter 8 outlining approaches to estimating trip generation, with references to the ITE *Trip Generation Handbook* Recommended Practice. Use of the Handbook allows users to better understand and apply the data published in TGM.

Land Use Changes

To ensure the data accurately reflect the composition of each land use, certain data were reassigned to other land uses, corrected, or removed from the database. Several new land uses were also introduced, based on newly submitted data and reclassification of existing land uses.

With the removal of data prior to 1990, the amount of data available for some land uses is limited compared to previous editions. In some cases, the removal of this data resulted in lower trip generation rates for some independent variables, such as industrial and office trip generation rates per square foot. This is especially true for land uses where the 12th edition data collection was limited. ITE encourages practitioners to submit recent data for all land uses. Chapter 9 outlines a procedure for TGM updates.

Port, Freight, and Terminal Land Uses (000s)

- General Aviation Airport (Land Use 022) was removed because all data points were collected prior to 1990.
- Truck and Trailer Parking (Land Use 035) was added as a new land use.
- An independent variable—Annual Enplanements (1000s)—was introduced for Commercial Airport (Land Use 021).

Industrial Land Uses (100s)

- Warehousing (Land Use 150) was renamed Warehouse (Land Use 150) for consistency with current industry terminology.
- The independent variable Occupied Units was removed for Mini-Warehouse (Land Use 151).
- Warehouse-related land uses (154, 155, 156, 157) include an updated definition of the independent variable Gross Floor Area (GFA). These land uses have an alternate definition of mezzanine, which affects how GFA is measured. For these land uses, GFA does NOT include the floor area of the mezzanine. Each land use description page provides additional discussion on this distinction.
- Industrial Recycling Facility (Land Use 175) was added as a new land use.
- Marijuana Cultivation and Processing Facility (Land Use 190) was renamed Cannabis Cultivation and Processing Facility (Land Use 190).

Residential Land Uses (200s)

- Senior Adult Housing—Multifamily (Land Use 252) was removed from Volume 2 (urban) because all data points were collected prior to 1990.
- Residential Planned Unit Development (Land Use 270) was removed because all data points were collected prior to 1990.

Lodging Land Uses (300s)

- Business Hotel (Land Use 312) was renamed Limited-Service Hotel (Land Use 312).
- The independent variable Occupied Units was removed from all lodging uses.

Recreational Land Uses (400s)

- Dog Park (Land Use 414) was added as a new land use.
- An independent variable—Campsites—was introduced for Campground/Recreational Vehicle Park (Land Use 416).
- Marina (Land Use 420) was removed because all data points were collected prior to 1990.
- Amusement Park (Land Use 480) was removed because all data points were collected prior to 1990.
- Soccer Complex (Land Use 488) was renamed Soccer Field (Land Use 488).
- Pickleball Courts (Land Use 489) was added as a new land use.
- The independent variable “Tennis Courts” was renamed “Courts” and is now used for Pickleball Courts (Land Use 489) and Tennis Courts (Land Use 490).
- Health/Fitness Club (Land Use 492) and Athletic Club (Land Use 493) were reexamined, and some data were reassigned. Additional clarification was also added to the land use descriptions.
- Boutique Fitness Studio (Land Use 494) was added as a new land use.

Institutional Land Uses (500s)

- Charter High School (Land Use 539) was added as a new land use.

Medical Land Uses (600s)

- Clinic (Land Use 630) was renamed Walk-In Clinic (Land Use 630).

Retail (800s)

- Nursery (Wholesale) (Land Use 818) was removed because all data points were collected prior to 1990.
- Marijuana Dispensary (Land Use 882) was renamed Cannabis Dispensary (Land Use 882).
- Furniture Store (Land Use 890) was renamed Furniture/Flooring Store (Land Use 890).

Services Land Uses (900s)

- Hair Salon (Land Use 918) was renamed Hair Salon/Spa (Land Use 918).
- A new land use for High-Volume Fast-Food Restaurant (Land Use 929) was added.
- Truck Stop (Land Use 950) was removed after reexamination of the study sites in the database. Applicable data was moved to the new land use Travel Center (Land Use 955).
- A new land use for Travel Center (Land Use 955) was added.
- A new land use for Rental Car Facility (Land Use 960) was added with a land use subcategory for proximity to airports.
- The independent variable—gross floor area—was modified to refer only to the area of the tasting room, not the entire building that houses the tasting room for Wine Tasting Room (Land Use 970)

4 Definition of Terms

The definitions presented in this chapter are intended for use in the *Trip Generation Manual* (TGM). The terms are grouped as follows:

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

Trip Types

TGM includes trip rates for each mode (vehicle, walk, bicycle, transit, truck), as well as person trips. The definitions for each are provided below.

Bicycle Trip—An inbound or outbound person trip where the longest segment between origin and destination is traveled by a bicycle or any pedal-powered vehicle.

Person Trip—A trip made by an individual person using any mode of travel from an origin to a destination. Each person counts as one trip, regardless of vehicle occupancy. For example, three people leaving a site in one vehicle generate 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) taxis, paratransit, and vanpools (including airport shuttles); and (3) pick-up trucks not being used for commercial purposes.

Transit Trip—An inbound or outbound person trip that crosses the site cordon line in a transit vehicle or where the greatest distance traveled is by transit vehicle. Transit modes include bus, heavy rail (metro, subway, rapid transit), light rail (streetcar, tramway, trolley), commuter rail (regional rail), monorail, ferry boat, trolleybus, cable car, automated guideway transit (personal rapid transit), aerial tramway, and inclined plane. Taxis, paratransit vehicles, and vanpools are considered personal passenger vehicles, not transit.

Trip or Trip End—A single or one-direction person or vehicle movement with an origin or destination inside a study site. Each trip has two trip ends (entering and exiting). Each trip end is a part of a trip. For site trip generation analysis, the focus is typically on trips entering and exiting a single site.

Truck Trip—The movement of a commercial cargo transport vehicle across a site cordon line. This includes off-site parked vehicles that load or unload cargo bound to or from the study site. Commercial cargo is typically transported in either medium-duty or heavy-duty trucks. A service vehicle entering or exiting a site is not considered a truck trip.

Vehicle Trip—The movement of a personal passenger vehicle or truck that transports a person across the site cordon line. “Vehicle trip” refers to the number of vehicles entering or exiting a site. For example, if a

person parks off-site and walks to an office building, the trip is considered an entering vehicle trip for the office building. However, if a person travels by transit and walks the final distance, the trip is counted as a transit trip, not a vehicle trip.

Walk Trip—An inbound or outbound person trip where the greatest distance traveled is on foot or via any type of assistive device (e.g., wheelchair, scooter, skates, or skateboard).

Walk+Bike+Transit Trip—An inbound or outbound person trip made by walking, bicycling, or transit.

Setting/Location

Center City Core—The downtown area of a major metropolitan region, typically the focal point of a regional light- or heavy-rail transit system. This area is characterized by multi-storied buildings, diverse land uses, an extensive pedestrian sidewalk network, and shared/priced parking both on-street and in structured garages or surface lots. It is generally an employment destination and includes an adjacent commercial core.

Dense Multi-Use Urban—A fully (or nearly fully) developed area with diverse and interacting complementary land uses; good pedestrian connectivity; and convenient and frequent transit. It may be a well-developed urban area outside a major metropolitan downtown or a mid-sized urban area downtown. Common land uses include office, retail, residential, entertainment, hotel, and other commercial uses. The residential uses are typically multifamily or single-family on lots no larger than one-fourth acre. Buildings often have minimal setbacks from the sidewalk. Vehicles remain the primary mode of travel, but the area also supports walking, biking, and transit. Parking is provided on and off-street. The complementary land uses in dense multi-urban areas provide the opportunity for short trips within the area, made convenient by walking, biking, or transit. Significant transit access, such as rail or bus, supports high transit mode share.

General Urban/Suburban—A predominantly vehicle-oriented area where most person trips are made by personal or commercial vehicle. These areas may be fully developed (or nearly so) at low to medium density and typically contain a mix of residential and commercial land uses. Commercial uses are often located at intersections or along corridors and surrounded by parking. These corridors are often situated near 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. Although the land uses are geographically close, a lack of pedestrian, bicycling, and transit infrastructure discourages non-vehicle travel.

Rural—An agricultural or undeveloped area with scattered parcels and very low population density.

Time Periods

Friday—A continuous 24-hour period during a Friday.

Friday, Peak Hour of Generator—The one-hour period with the highest volume of vehicle or person trips entering and exiting a site on a Friday. This peak may occur during either the AM or PM.

Friday, Peak Hour of Adjacent Street Traffic—The one-hour period during the morning or evening commuter peak periods when combined site-generated vehicle traffic and adjacent street traffic is the highest on a Friday. If 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. Recent studies have indicated that peak periods can be longer in heavily populated areas.

Saturday—A continuous 24-hour period during a Saturday.

Saturday, Midday Peak Hour of Generator—The one-hour period between 11:00 a.m. and 1:00 p.m. on Saturday with the highest volume of vehicle or person trips entering and exiting a site.

Saturday, Peak Hour of Generator—The hour with the highest volume of vehicle or person trips entering and exiting a site on a Saturday. This peak may occur during either the AM or PM.

Sunday—A continuous 24-hour period during a Sunday.

Sunday, Peak Hour of Generator—The hour with the highest volume of vehicle or person trips entering and exiting a site on a Sunday. This peak may occur during either the AM or PM.

Weekday—A continuous 24-hour period typically based on data collected Monday through Friday. The period can span two days.

Weekday, Peak Hour of Adjacent Street Traffic—The one-hour period during weekday morning or evening commuter peak periods when combined site-generated and adjacent street traffic is the highest (typically based on data collected Monday through Friday). If 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 peak periods can be longer in heavily populated areas.

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

Independent Variables

Acre—A unit of measurement equal to 43,560 square feet. In TGM, this refers to the total gross area of a development site. Because submitted site acreage may not always distinguish between total and developed acres, caution is advised. When submitting data, analysts should specify both total acreage and the percentage of developed acreage.

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)**. This value includes all traffic on abutting streets with direct access to the development site. If the site is served by a service road, the adjacent street includes any roadway that provides access to the service road, even if not directly contiguous to the site. Traffic on roadways without direct access to the site is excluded.

Annual Enplanements—The total number of passengers whose commercial airline flight originates at the airport under study within a given year.

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

Bed—A designated sleeping place for a group quarters resident or medical facility patient.

Bedroom—A designated room for sleeping that contains one or more beds.

Bowling Lane—A single lane available for bowling.

Cage—A designated location for a person to hit baseballs or softballs within a contained area.

Campsite—A location used for overnight outdoor stays. Campsite includes all campsites within a campground. **Occupied Campsite** is a related independent variable.

Car Wash Tunnel—An enclosed series of stationary car wash components that can process a single row of motor vehicles, typically with the aid of a conveyor system.

Courts—Indoor or outdoor facilities specifically designed for tennis or pickleball.

Daily Customer—A person who visits a building 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. Includes lanes used solely for Automated Teller Machine (ATM) transactions.

Drive-Through Lane—A lane at a restaurant that enables motorists to pick-up food or beverages without leaving their vehicles. A single pick-up window fed by dual order lanes is considered a single drive-through lane.

Dwelling Unit—A residential location such as a house, apartment, condominium, townhouse, mobile home, or manufactured home where people may 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 hour or day the data are collected.

Family Members—The total number of individuals identified as members of a specific place of worship. **Member** is a related term.

Field—Any outdoor area that is constructed, equipped, and/or marked for outdoor recreational activities.

Food Cart—A mobile kitchen used to prepare and sell cooked food to customers.

Gaming Position—An individual seat at which a person may engage in a gaming activity, such as at a slot machine.

Gross Floor Area (GFA)—The total area of all levels of a building, expressed in square feet. It includes cellars, basements, mezzanines, penthouses, corridors, lobbies, stores, and offices located within the principal outside faces of exterior walls, but excludes architectural setbacks or projections. All areas with a floor surface and a minimum clear standing headroom of 6 feet 6 inches are included, regardless of use. With the exception of buildings containing enclosed malls or atriums, GFA is equivalent to gross leasable area and gross rentable area. If a ground-level area, or part thereof, within the principal outside faces of the exterior walls is unenclosed, this floor area is still considered part of the overall GFA. However, unroofed areas and unenclosed roofed-over spaces—except those contained within the principal outside faces of

exterior walls—should be excluded from GFA calculations. For **warehouse-related land uses** (154, 155, 156 and 157), an alternate definition of mezzanine is applied and therefore has a different definition of GFA. For these land uses, mezzanine floor area is NOT included in the reported GFA. Each applicable land use description page provides additional discussion on this topic. For the purpose of trip generation calculation, the floor area of all parking garages within the building should be excluded in the GFA. The majority of land uses in the *Trip Generation Manual* use GFA as an independent variable.

Gross Leasable Area (GLA)—The total floor area designed for tenant occupancy and exclusive use, expressed in square feet. It includes any basements, mezzanines, or upper floors and is measured from the centerline of joint partitions and from outside faces of exterior walls. For the purpose of trip generation calculation, the floor area of all parking garages should be excluded from the building's GLA. GLA represents the space for which tenants pay rent and that generates income for the property owner. Leased spaces not in productive use are not considered occupied. In the retail industry, GLA is widely adopted as the standard measurement for statistical comparison. Accordingly, GLA is used in the *Trip Generation Manual* for shopping centers. For specialty retail centers, strip centers, discount stores, and freestanding retail facilities, GLA typically equals GFA.

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

Lift—A mechanism used to transport skiers uphill on a ski slope, typically consisting of seats or benches attached to an overhead cable.

Member—An individual who belongs to a group or organization. Family Member is a related term.

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

Movie Screen—A room within a movie theater that contains seating and the equipment necessary to present of a movie.

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

Net Rentable Area—The total square footage of all storage units in a self-storage facility.

Occupied Campsite—(See **Campsite**.)

Occupied Parking Space—(See **Parking Space**.)

Parking Space—An individual stall within a parking lot or garage designated for a private motor vehicle. An **Occupied Parking Space** refers to a space currently in use by a parked vehicle.

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 section of a building used for lodging, such as in a hotel or motel.

Seat—A designated place where an individual may sit; multiple seats may exist along a bench or pew.

Service Bay—A designated location within an automobile servicing facility where a vehicle can be parked to be inspected and/or repaired.

Servicing Position—A location within a quick-lubrication or other vehicle repair shop where 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.

Storage Unit—A vault rented for the storage of goods, typically within a self-storage facility. Storage Unit is distinct from a **Unit**, which has a different definition.

Student—A person enrolled in an institution such as a school, college, or day care center, either full-time or part-time. The number of students refers to the total enrollment, not just those present at the time of data collection.

Tee/Driving Position—A designated location from which a golf ball is struck for practice.

Unit—In the context of Land Use Code 255 (Continuing Care Retirement Community), a unit refers to a group of rooms intended for residential dwelling. **Storage Unit** is a similar term with a different definition.

Vehicle Fueling Position—The number of vehicles that can be fueled simultaneously at a service station. For example, a service station with two pumps, each with hoses on both sides, allows four vehicles to fuel at once—therefore, it has four fueling positions.

Vendor—An individual or company offering goods or services 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 (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 total number of trips for all contributing data point sites by the total of all independent variable units across those sites. The weighted average rate is used—rather than the simple average of individual site rates—to account for the variance within the data set. Data sets with a large variance will over-influence the average rate if they are not weighted. Data plots include a dashed line representing the weighted average rate, extending between the lowest and highest observed independent variable values.

Trip Ends, T—The number of vehicle or person trips recorded at a site; shown as the dependent variable on the y-axis of the data plot.

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 percentage of total trips entering and exiting a site during the indicated time period.

Fitted Curve and Fitted Curve Equation—The result of a single-variable regression analysis between the independent and dependent variables, expressed in an optimal mathematical relationship.

- For a linear relationship: $T = aX + b$.
- For a logarithmic relationship: $Ln(T) = a\ Ln(X) + b$.

The fitted curve is depicted as a solid line on the data plot, extending between the lowest and highest observed independent variable values.

Independent Variable, X—A physical, measurable, and predictable characteristic describing the study site or baseline site (for example, gross floor area) that directly correlates with the trip generated of a land use. Note: Sometimes referred to as an explanatory variable.

Number of Studies—The total number of individual studies reported on a specific data page.

Range of Rates—The minimum and maximum trip generation rates observed across all reported studies.

Standard Deviation—A measure of data dispersion relative to the calculated average. A lower standard deviation indicates less dispersion and a better fit to the average rate. In TGM, the reported standard deviation is based on the weighted average, not the mean. Standard deviation values are reported only when there are three or more data points.

Study Site—A data point plotted on the graph representing a trip generation study conducted for a specific land use code.

5 Description of Database

The data analyzed in this manual were contributed voluntarily by state and local government agencies, consulting firms, individual transportation professionals, universities and colleges, developers, associations, and ITE local districts, sections, and student chapters. In many cases, the data were originally contained in published reports or unpublished analyses conducted by these groups. Sources are listed in Chapter 10. ITE Headquarters did not conduct any original field surveys.

The amount of data submitted for individual sites varies from a single peak-hour volume to seven days of directional hourly volumes. All available data are combined to maximize the size of the database for each land use and time period. Before being entered into the comprehensive database, all submitted data are examined by ITE staff for validity and reasonableness.

Data Collection

Some submitted data were collected through manual counts; others were obtained using automatic counters or video footage. All count locations excluded through traffic. Automatic counters were configured to count vehicular traffic entering and exiting sites, with driveway placement carefully selected to avoid double counting turning vehicles. In some cases, counts were non-directional and did not distinguish between entering and exiting traffic.

Manual counts often supplemented automatic counts to collect vehicle occupancy and classification data, verify the accuracy of the automatic counters, and obtain directional counts during peak periods. In other cases, only manual vehicle or person counts were conducted during peak periods. At certain sites, intercept surveys were conducted to determine the travel modes of persons entering or exiting the site.

For the 12th Edition of TGM, ITE also reviewed satellite map imagery to identify potential sites for data collection. Directional traffic data at these sites were obtained through post-processed video footage, while independent variable values were determined through research and direct communication with the respective developments. Compiled trip generation data on vehicles, pedestrians, and bicyclists were entered into the database. Additional site characteristics were obtained through internet searches, personal interviews, actual measurements, telephone conversations, and other correspondence.

Data Analysis and Storage

Each study site data record stored by ITE includes, where available, the following information:

- Contributor name, address, and contact information
- Site name and address (municipality, state/province)
- Date of the trip generation count (month/day/year and day of the week)
- General site characteristics (for appropriate land use classification)
- Specific site characteristics corresponding to the land use independent variables
- Trips by type by time period

New data records are regularly collected; however, no changes are made to the database that produces 12th Edition data plots—except documented corrections published via errata and explicitly announced to all purchasers.

Data Age

The current database contains data collected from 1990 onward. The ITETripGen web app enables a user to filter trip generation data by time period to create customized data plots and associated statistics. While filtering the data by age may provide useful insights, analysts should exercise caution. A filtered subset may not necessarily constitute a balance of potential land use characteristics. As the database is filtered and the dataset diminishes, the likelihood of achieving a representative cross-section decreases.

Variations in the Statistics

Variation in trip generation characteristics for specific land uses is reflected in the range of rates, standard deviation, and coefficient of determination (R^2) value. These variations may be due to small sample sizes, site-specific marketing or economic factors, geographic differences, or unique site characteristics. Accordingly, judgment must be exercised in the use of the statistics in this manual.

Additional variation may result from differences in the duration of traffic counts; the season during which the traffic volumes were counted; and geographic location of the study site. The ITETripGen web app allows users to filter data by geographic region within the U.S. and Canada.

Limitations of the Data Plots

Variations in trip generation characteristics for specific land uses often produce scatter diagrams in the *Trip Generation Manual* data plots. These variations may result from small sample sizes; differences in economic conditions at the times of data collection; differences in the settings; unique site characteristics of the specific sites; or daily, seasonal, and geographic fluctuations. Accordingly, professional judgment must be exercised when interpreting the reported data and statistics.

Data plots represent only the range of independent variable values for which data are available. Caution should be used if extrapolating the data beyond the documented ranges, as no data exist to characterize trip generation behavior beyond the available ranges.

In some data plots, the fitted curve equation produces significantly large or negative y-intercept. For independent variables with low values, the fitted curve equation may yield unreasonable trips estimates (e.g., fewer than zero trips), particularly when applied outside the observed data range.

In rare cases—due to limited sample size and data variability—the projected trip generation for the peak hour of the adjacent street traffic may exceed the peak hour trip generation for the generator, which is theoretically impossible. Similarly, some TGM data plots show more vehicle trips than person trips, which is also impossible given that person trips must equal or exceed vehicle trips. Lastly, small samples sometimes show illogical decreases in trips as the independent variable increases. In these rare instances, professionals should use their site-specific knowledge and judgment to determine the best trip generation estimate.

6 Description of Data Plot Pages and Reported Statistics

Data Plot Organization

For every land use, statistics and data plots are presented for at least one independent variable and for at least one time period. For each land use, the data plots are organized in the following manner:

- First by setting
- Then by land use subcategory, if applicable
- Then by trip type
- Then by independent variable
- Then by time period

Data Plot Content

Data plots provide a fundamental display of the variance within the database. It is important to note that the data points on the plots represent **the observed number of trips**, not trip generation rates, plotted against the value of the independent variable.

Each data plot corresponds to a specific trip travel mode for a single combination of land use, land use subcategory, independent variable, time period, and setting. The standard data plot layout clearly identifies these defining factors, including the trip type. A lightly shaded watermark illustrating the travel mode is included in the background of the data plot.

For many land uses, the analyst can have strong confidence in the trip generation relationships presented in the 12th Edition. For others, where the data set is small, plots serve only as an initial indication of trip generation. Each plot with five or fewer data points includes the statement “Caution—Small Sample Size” above the plot area.

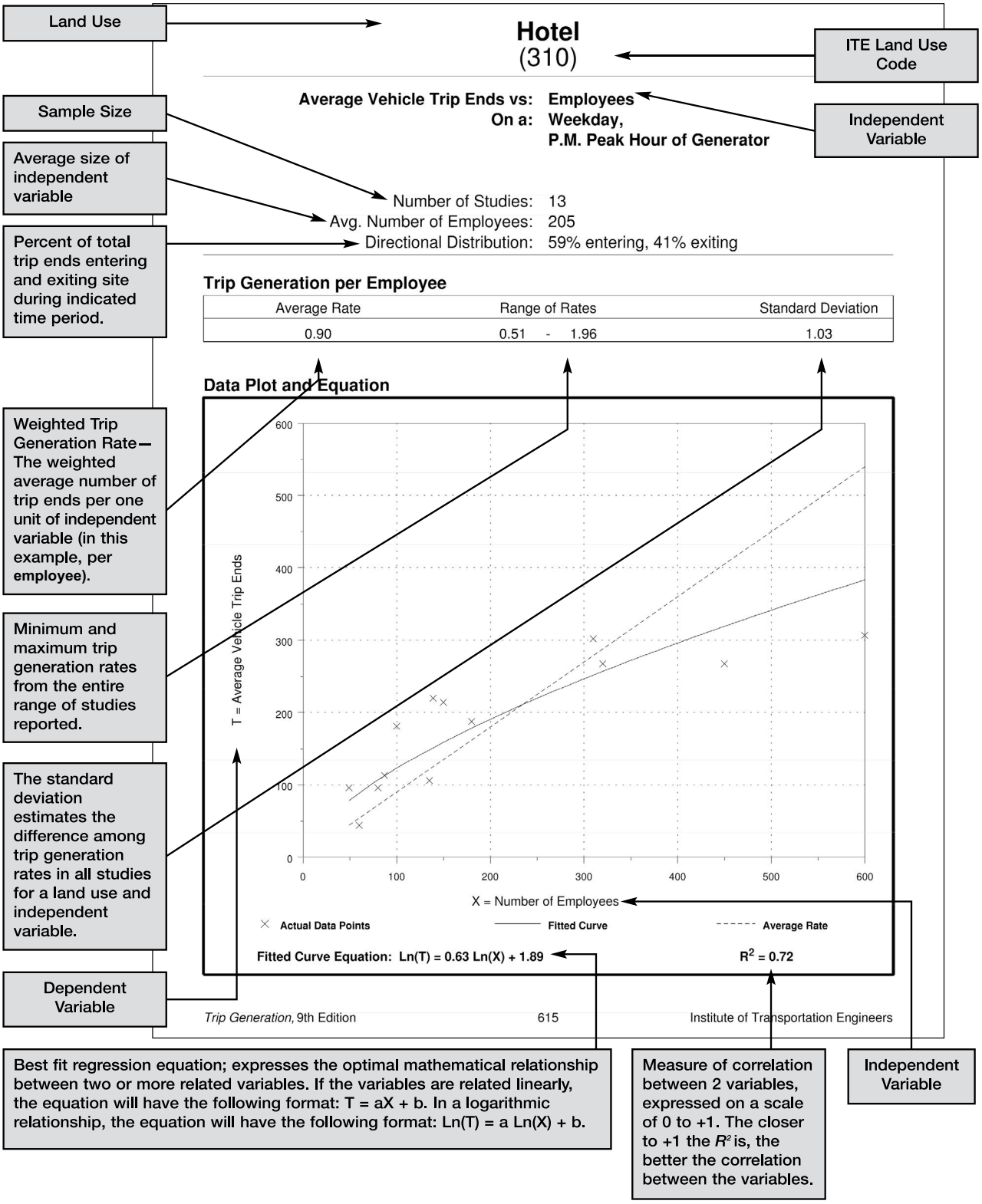
For some plots generated through the ITETripGen web app, the statement “Caution—Incomplete Data Set” may also appear above the plot area, indicating that the plot is based on a filtered subset rather than the entire database.

Data Plot Format

Figure 1 is a sample data plot illustrating the format for presenting statistical and descriptive information for a single land use, a specified independent variable, and a specified time period. The sample data page explains each element of the figure. Figure 1 is published in the *Trip Generation Handbook, 3rd Edition*; plots contained in TGM 12th Edition include some modifications to this figure such as inclusion of the setting/location and other minor formatting differences.

Each data point within a data plot represents the observed number of trips entering or exiting a single site, plotted against the value of the independent variable for the site.

Figure 1. Sample Data Page in *Trip Generation Manual*



Source: *Trip Generation Handbook, 3rd Edition*, Institute of Transportation Engineers, Washington, DC, 2017.

Reported Statistics

Average Trip Rate

The average trip generation rates displayed in the data plots are calculated using a **weighted average trip rate**, rather than the average of the individual rates. This approach minimizes the influence of outliers, as individual sites with large variances would otherwise skew the average.

Standard Deviation for the Weighted Average Trip Rate

The **standard deviation** measures how widely dispersed data points are around the calculated average. A lower standard deviation indicates a better fit to the average. Because the statistics are based on weighted averages—not simple arithmetic average—the reported standard deviation is an approximation and not statistically precise. The approximated standard deviations are provided for plots with three or more data points.

Regression Analysis

Each data plot (for every combination of land use, land use subcategory, independent variable, time period, setting, and trip type) shows a dashed line representing the average trip rate.

If there are at least four data points, the ITE TripGen web app evaluates whether a regression curve can be developed between the number of trips and the independent variable. The curve with the best (i.e., highest) coefficient of determination (R^2) is determined for each data plot. If the R^2 value is at least 0.50, the fitted curve equation and its coefficient of determination (R^2) are displayed on the plot.

The coefficient of determination is defined as the percent of the variance in the number of 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. An R^2 value closer to 1.0 indicates a better fit; an R^2 value closer to 0 indicates a weaker fit. The fitted curve equation with the highest R^2 value is presented. Unlike the weighted average rate, the plotted fitted curve equation does not necessarily pass through the origin and may not be linear.

The following two general forms of fitted curve equations are considered:

Linear: $T = aX + b$

Logarithmic: $Ln(T) = aLn(X) + b$

Where X is the independent variable and T (the number of trips) is the dependent variable. The regression analysis determines the values of *a* and *b* that minimize the expected error in estimating the dependent variable.

In some cases, fitted equations yield a large or negative y-intercept, producing illogical trip-end estimates for small values of the independent variable. In such instances, caution should be used, and users are referred to Chapter 3, “Process for Estimating Trips Generated by a Study Site,” in the *Trip Generation Handbook*, 3rd Edition, for additional guidance.

Variations in the Statistics

Variation in trip generation characteristics for specific land uses is reflected in the range of rates, standard deviation, and coefficient of determination (R^2) value. These variations may be due to small sample sizes, site-specific marketing or economic factors, geographic differences, or unique site characteristics. Accordingly, judgment must be exercised in the use of the statistics in this manual.

Additional variation may result from differences in the duration of traffic counts; the season during which the traffic volumes were counted; and geographic location of the study site. The ITETripGen web app allows users to filter data by geographic region within the U.S. and Canada.

Cautions

The plots presented in the *Trip Generation Manual* cover only the ranges of independent variables for which data are available. Extrapolation beyond these ranges should be approached with caution, as no data exist to validate trip generation characteristics outside the documented bounds.

Even plots based on a single data point are included as reference. Extreme caution should be used in applying trip relationships derived from a single point. ITE hopes that inclusion of even the smallest dataset may stimulate new data collection and submission, further filling the gaps in the database.

7 Instructions

The *Trip Generation Manual* provides three primary methods for estimating trips at an existing or proposed development:

1. **Graphic Plot—**A plot of trip ends versus the independent variable, used for rough visual estimation.
2. **Weighted Average Trip Rate—**A numerical estimate based on weighted averages (number of weighted trip ends per unit of the independent variable).
3. **Regression Equation—**A mathematical relationship between trip ends and the independent variable units.

Understanding the Methodologies

Selecting an appropriate trip estimation method requires the application of engineering judgment and a thorough understanding of the three methodologies listed above. The *Trip Generation Handbook*, Chapter 4, provides additional guidance, including a detailed, step-by-step approach for using the *Trip Generation Manual* data to estimate trips. Users are encouraged to reference this material. The *Handbook's* methodology is preferred over arbitrary policies because it accounts for data quality and is therefore more likely to yield accurate results.

Graphic Plot

The most fundamental display of available information is a plot of 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 sufficient data points exist within the range of the independent variable being considered. However, where data are sparse, or when interpreting "erratic" data points or interpolating between points, inconsistencies can arise, requiring analyst judgment.

Weighted Average Trip Rate

The traditional method of forecasting trips is to apply a weighted average trip rate. Trips are 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 weighted average trip generation rate—simplified as "average trip rate" in the data plots—is defined as the number of weighted trips per unit of the independent variable. This approach assumes a simple linear relationship between trips and the independent variable, having a slope equal to the rate and with the straight line passing through the origin. If the independent variable equals zero, then trip generation is also zero. Therefore, the number of trips can be estimated by multiplying the number of trips per unit of independent variable by the number of units of the independent variable associated with the study site. Every data plot contains a dashed line corresponding to the weighted average rate, extending between the lowest and highest values for the independent variable values among the study sites.

Weighted averages are used rather than the average of the individual rates for all development sites with data to minimize the influence of outlier sites with large variances from the mean. Calculation of weighted average rate is demonstrated in the *Trip Generation Handbook*, Appendix J.

If all data points correspond to the same independent variable value, no line is drawn; however, the weighted average rate is still listed. As an example, Land Use 944 (Gasoline/Service Station) has vehicle fueling positions as an independent variable. If all the data points have four fueling positions, a line corresponding to an average rate cannot be drawn. The weighted average rate would still be listed on the data page.

Regression Equation

Regression analysis develops a fitted curve equation that defines the mathematical relationship between trips and the independent variable.

Using the regression equation allows direct forecasting of trip ends without needing to interpolate between plotted points. Unlike the weighted average rate, the plotted regression curve does not necessarily pass through the origin, and the relationship may not be linear.

Key statistical measures include:

- **Correlation Coefficient (R)—** A measure of the degree of association or closeness between variables.
- **Coefficient of Determination (R^2)—**The percent of variance in trip numbers 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 means that 64 percent of the trip variance 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.

For additional information on regression equations, see the “Regression Analysis” section in Chapter 6.

Sample Problem

The following sample problem demonstrates the use of both the regression equation and the weighted average trip generation rate equations to calculate trip generation.

Problem:

Estimate the number of vehicle trips generated by a medical-dental office building (Land Use 720) during the weekday afternoon peak period of adjacent street traffic. The site GFA is 60,000 square feet and the site is located in a general urban/suburban setting within/near a hospital campus.

Methods:

- **Weighted Average Rate** is 2.20 trip ends per 1,000 sq. ft. GFA
  Vehicle trips for subject site:
  T = 2.20 x 60 = 132 vehicle trip ends
- **Fitted Curve Equation** is T = 2.26(X) – 2.57
  Vehicle trips for subject site:
  T = (2.26 x 60) – 2.57 = 133 vehicle trip ends

8 Approaches for Estimating Trip Generation

Trip Generation Manual (TGM) is a periodic publication from ITE—A Community of Transportation Professionals (ITE), developed through a staff-led process using voluntarily submitted data from ITE members and the transportation community. More information about the Manual and its development is provided in Chapter 1, *Introduction*.

Separately, ITE also develops a supplemental resource, *Trip Generation Handbook* (TGH), which offers guidance on how to use and interpret the data in TGM. The most recent edition of TGH is the 3rd edition, published in September 2017. TGH is an ITE Recommended Practice, developed through a formal, consensus-based process and designed to provide clear procedures and best practices for transportation professionals. Because ITE Recommended Practices are developed through a formal review and consensus process, TGH offers practitioners detailed procedures and applications. In contrast, TGM serves as an informational resource and does not prescribe specific methodologies.

This chapter introduces TGH content that may aid TGM users when conducting trip generation analyses, including:

- Key factors for estimating person trips
- Key factors for estimating truck trip generation
- Key considerations for evaluating trip generation in mixed-use developments, urban infill or redevelopment projects, and transit-friendly developments
- The use of local data to estimate trip generation
- Considerations related to the application of pass-by and diverted trips

Person Trips

When available, TGM includes data for each mode (vehicle, walk, bicycle, transit, truck) as well as person trips. If person trips are not available, analysts may need to adjust baseline vehicle trip generation to account for multimodal travel, particularly in suburban or rural areas. Chapter 5 of TGH outlines how to estimate person trips for non-urban sites when person trips are not available.

Truck Trip Generation

The technical appendices in TGM provide truck trip generation plots by land use for land uses where data are available. These appendices are accessible through the ITETripGen web app. When truck trip generation data are unavailable for a given land use, analysts can apply the procedures detailed in Chapter 11 of TGH. This method, based on the National Cooperative Freight Research Program (NCFRP) Report 26: *Guidebook for Developing Subnational Commodity Flow Data*[1], suggests use of a “playbook” to facilitate appropriate selection and analysis of truck trip generation data.

[1] Cambridge Systematics, Inc., K. Casavant, A. Goodchild, E. Jessup, and C. Lawson. NCFRP Report 26: *Guidebook for Developing Subnational Commodity Flow Data*. Washington, DC: Transportation Research Board, 2013.

Trip Generation for Mixed Use, Urban Infill/Redevelopment, and Transit-Friendly Developments

Applying baseline trip generation rates to mixed-use or multimodal sites in suburban or rural areas without making appropriate adjustments may lead to an overestimation of vehicle trips. TGH provides guidance for evaluating:

- Mixed-use developments
- Urban infill/redevelopment projects
- Transit-friendly developments

Mixed-Use Development

A mixed-use development typically combines two or more land use types (each corresponding to an ITE land use code) within a single real-estate development, allowing internal trips between uses without accessing the external road system. When multiple land uses are present on a single site, there is potential for interaction among those uses—referred to as internal capture trips—particularly when trips can be made on foot. As a result, the total number of external trips (i.e., trips entering or exiting the site) may be lower than the simple sum of trips generated by each individual land use.

Chapter 6 of TGH presents the recommended procedure for estimating trip generation at mixed-use developments, as developed in NCHRP Report 684: *Enhancing Internal Trip Capture Estimation for Mixed-Use Developments*[2]. The NCHRP report details the development of the recommended estimation procedure, its underlying data, and validation of the internal trip estimation procedure. It includes a summary of past research on trip generation and internal trip capture at mixed-use developments, and reviews alternative trip capture methods that analyst may consider.

Important caution: Internal capture adjustments should not be applied to individual ITE land uses that inherently reflect mixed-use characteristics (e.g., shopping center, Land Use 820). For example, a shopping center typically contains uses other than general retail such as restaurants, banks, and offices. However, because data have been collected directly from stand-alone shopping center developments, shopping centers are considered a single land use in the TGM. The associated trip generation data presented in TGM already reflects the effects of internal capture and the mixed-use nature of the center, and no further adjustments are needed.

Trip Generation for Urban Infill/Redevelopment

An infill site is one where the surrounding area within a one-half mile radius is mostly developed (typically more than 80 percent). An infill site can be in or around a central business district, urban core, suburban business district, or any other area that is substantially developed.

If urban-specific data are not available in TGM for a particular land use, Chapter 7 of TGH presents the recommended procedure for estimating person and vehicle trip generation for compact, urbanized, mostly developed areas where walking, bicycling, and transit are viable modes of transportation. The approach draws from the research findings and was selected for its ease of application and likelihood of widespread acceptance.

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[2] Bochner, B., K. Hooper, B. Sperry, and R. Dunphy. NCHRP Report 684: *Enhancing Internal Trip Capture Estimation for Mixed-Use Developments*. Washington, DC: Transportation Research Board, 2011.

Trip Generation for Transit-Friendly Development

TGM presents transit trip generation information for some land use categories. If data are not available, Chapter 8 of TGH presents a recommended approach for forecasting the number of transit trips generated by a proposed development.

For TGH purposes, a transit-friendly development (TFD) is any development that is directly connected, immediately adjacent to, or directly oriented toward a rail or rapid transit station or stop (including heavy rail, light rail, streetcar, commuter rail, or bus rapid transit) or a multi-route bus transit center with high-frequency service. Although the more common term in research and ordinances is transit-oriented development (TOD)—and the precise definition does vary—TGH uses TFD to maintain a consistent, clearly defined term applicable across its guidance.

Use of Local Data to Estimate Trip Generation

Chapter 4 of TGH presents a recommended process for assessing the appropriateness of TGM data for estimating trip generation for a specific site. Chapter 9 presents a recommended procedure for estimating trip generation using local trip generation data.

TGH emphasizes that the premise of this guidance is the assumption that sites in one metropolitan area will generally have trip generation characteristics comparable to those of a development site in another metropolitan area if the site settings are similar. In contrast, two development sites in the same state or same local jurisdiction may have different trip generation characteristics because of significant differences in their settings. For example, TGH explains that the analyst should expect vehicle trip generation characteristics to be different between sites located in a downtown setting versus sites located in a suburban setting. Likewise, a site located near and with accessibility to major transit service can exhibit a lower vehicle trip generation rate than a similarly located site with no transit service.

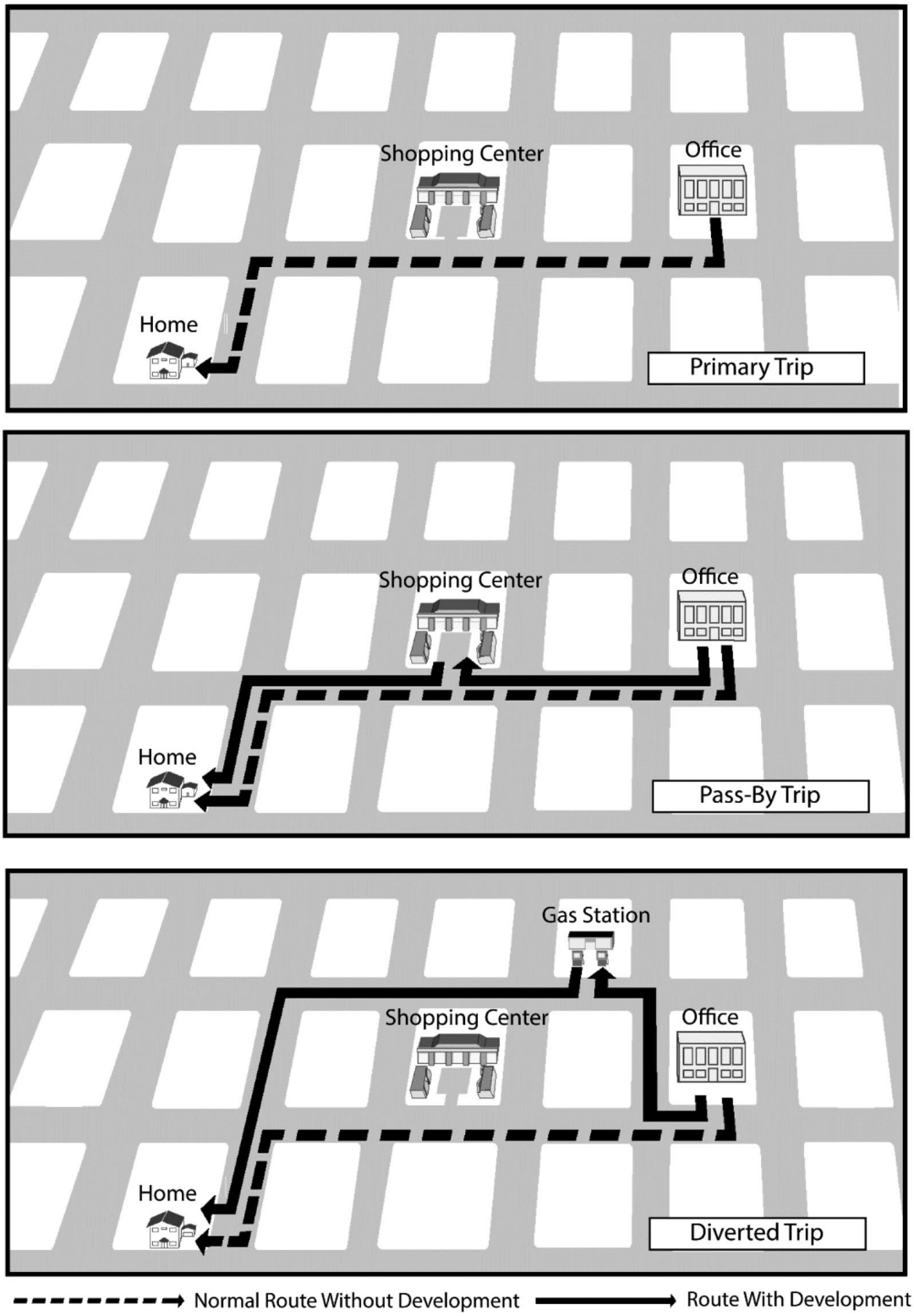
Primary, Pass-By, and Diverted Trips

Not all traffic entering or exiting a site driveway is new traffic added to the street system. The actual amount of new traffic depends on the purpose of the trip and the route taken from its origin to its destination. For example, retail-oriented developments—such as shopping centers, discount stores, restaurants, banks, service stations, and convenience markets—are often located adjacent to busy streets specifically to attract travelers already on the street system passing by for other purposes. As a result, a portion of the trips generated at these sites, known as pass-by trips, are drawn from existing traffic rather than creating new vehicle trips on the adjacent street system. As such, pass-by trips can be subtracted from the total external trips generated by a study site.

Vehicle trips generated by a site can be separated into two major categories: pass-by trips and non-pass-by trips. In some transportation impact analysis applications, it is necessary to further subdivide non-pass-by trips into primary trips and diverted trips. These trip types are illustrated in Figure 2.

Chapter 10 of TGH presents the recommended procedure for assigning primary, pass-by, and diverted trips, along with specific definitions for these terms and supporting data tables for pass-by, diverted link and primary trips. It should be noted that the data tables originally contained in TGH have been updated, and the current versions are now presented in the appendices of TGM, accessible through the ITETripGen web app.

Figure 2. Primary, Pass-By, and Diverted Trips



Source: *Trip Generation Handbook, 3rd Edition,* Institute of Transportation Engineers, Washington, DC, 2017.

9 Procedure for Manual Updates

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 it to ITE Headquarters.

This procedure ensures a continual, uniform method of obtaining and summarizing 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 link to electronic submittal form
- 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 based on additional data
- Identify data collection needs in areas where deficiencies exist or where little information is available

Accurate trip generation estimates must be based on consistent, properly collected, and applicable data. Chapter 12 of the *Trip Generation Handbook* presents a recommended framework for collecting data pertinent to trip generation estimates. This framework is structured to be straightforward, easily replicated, and adaptable to any potential land use and development type.

An electronic system is available for submitting trip generation data to ITE. The site address is https://www.ite.org/ite-trip-generation-data-submission-portal/ Hard copy trip generation data collection forms are also available on the ITE Trip Generation web page. Data may also be submitted through direct transmittal of electronic files to the ITE Trip Generation email address provided below.

Completed forms should be returned to the following address:

ITE—A Community of Transportation Professionals
1627 Eye Street, NW, Suite 550
Washington, DC 20006 USA
Telephone: 202-785-0060
www.ite.org
E-mail: tripgen@ite.org

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