TRAFFIC ENGINEERING HANDBOOK
Fifth Edition

James L. Pline
Editor

Institute of Transportation Engineers
The Institute of Transportation Engineers (ITE) is an international educational and scientific association of transportation and traffic engineers and other professionals who are responsible for meeting mobility and safety needs. The Institute facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development and management for any mode of transportation by promoting professional development of members, supporting and encouraging education, stimulating research, developing public awareness, and exchanging professional information; and by maintaining a central point of reference and action.

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Preface

When the Institute of Traffic Engineers was created in 1930, one of the key roles the leadership identified for this new organization was to develop and disseminate technical information. Professionals and lay persons alike needed material to provide an objective understanding of transportation issues.

Consequently, in 1939, when ITE had fewer than 200 members, the Institute accepted a proposal from the National Conservation Bureau to prepare the first Traffic Engineering Handbook. This publication became a reality in 1941. It was truly a milestone accomplishment, representing the first book dedicated to the subject of traffic engineering.

The Institute has taken seriously the need to provide objective information pertaining to the state-of-the-art in transportation engineering. The 1941 Traffic Engineering Handbook was subsequently updated in 1950 and 1965. In 1976 and again in 1982, the first and second editions of the Transportation and Traffic Engineering Handbook were prepared. The revised title was a reflection of the broadening perspective being given to traffic engineering by the profession.

In updating the 1982 edition of the Transportation and Traffic Engineering Handbook, the editorial committee realized that the amount of relevant information that warranted inclusion had become extensive. Justification existed to prepare both a Traffic Engineering Handbook and a Transportation Planning Handbook. The initial publication of these two separate Handbooks occurred in 1992.

The editorial committee working on the 1999 update of the Handbooks determined that the practice of preparing two separate Handbooks should be continued. Each Handbook was carefully reviewed for state-of-the-art content and completeness. At the same time, both Handbooks are designed to be stand-alone publications. As a result, some duplication of material is necessary to assure that each Handbook adequately covers the necessary subject matter.

The primary purpose of the Handbooks is to provide practicing professionals and other interested parties with a basic day-to-day source of reference on the proven techniques of the practice. The Handbooks provide guidelines, and are not a documentation of standard practices. Although not intended to be used as textbooks, the Handbooks should serve as a valuable reference source. Each Handbook chapter contains a listing of key references.

The transportation engineering profession continues to broaden in scope. This is reflected by the new chapters in the 1999 editions that were not part of the 1992 editions. The world remains a dynamic place, and transportation continues to be key to economic competitiveness and quality of life. New issues—such as sustainable transportation, smart growth, seamless intermodal systems, innovative financing, and a recognition of the importance of better operating the transportation system—are increasingly becoming a part of what the profession must address. Many of these issues are touched upon in these Handbooks. No doubt the editors of future editions of the Handbooks will have the opportunity to significantly expand on the current knowledge base.

Dennis L. Christiansen, P.E.
Senior Editor

Wolfgang S. Homburger, P.E.
Associate Senior Editor
Acknowledgments

The planning and completion of the Traffic Engineering Handbook was a group effort of the authors, reviewers, editors, copyeditors, and ITE staff. This publication is the result of many hours of cooperation between people across different time zones, locales, and areas of employment. It is a tribute to our modern communications systems and the sharing of knowledge that the work was completed so quickly and successfully. The Handbook effort was organized in 1997 with the major work started following the ITE Annual Meeting. Chapter authors prepared their material in 1998 with the editing and publishing being done in 1999.

The opportunity to work with a diverse group of knowledgeable people is always a privilege and an enlightening experience. The cooperative effort of authors and reviewers to provide a final product on schedule was sincerely appreciated. Please recognize these people when you have an opportunity in your contacts and note their contribution to the knowledge in the profession. The efforts of ITE Headquarters staff in administering the project, guiding the schedule, and overseeing the editing and publishing process made the job much easier. My special thanks goes to Thomas W. Brahms, Shannon Gore Peters, Agneta Melén-Wilmot, and Ann O’Neill.

I must say that I have never worked with a better editorial board. Dennis Christiansen, John Edwards, and Wolf Homburger were very responsive and provided constructive assistance and necessary guidance to finish the Handbook on time and as planned. The opportunity to work with all of these people is sincerely appreciated.

James L. Pline
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CHAPTER 1
Introduction to Traffic Engineering

James L. Pline, P.E.
President, Pline Engineering, Inc.

Transportation is among the primary factors influencing society and the quality of life. Mobility is an integral component of successful economic development, industry, education, use of recreation facilities, national and international trade, and investment. The vast intermodal network of transportation facilities has created a complex society that depends on the continuing efficiency and economic vitality of freight and passenger services. Transportation engineering is the profession that makes it all work to serve the public, with traffic engineering representing a specific segment of the transportation field. Both are defined in more detail below.

What is Traffic Engineering?
The Institute of Transportation Engineers (ITE) defines transportation and traffic engineering as follows:

Transportation engineering is the application of technology and scientific principles to the planning, functional design, operation, and management of facilities for any mode of transportation in order to provide for the safe, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods.

Traffic engineering is that phase of transportation engineering which deals with the planning, geometric design, and traffic operations of roads, streets and highways, their networks, terminals, abutting lands, and relationships with other modes of transportation.

Although this definition has been in use for some time, it does not address all functions of the profession. The ITE Task Force working on traffic engineering certification found it necessary to provide a more precise definition. Accordingly, it defined traffic engineering as “that branch of engineering which applies technology, science, and human factors to the planning, design, operations and management of roads, streets, bikeways, highways, their networks, terminals, and abutting lands.” The objective of traffic engineering is to provide for the safe, rapid, comfortable, efficient, convenient, and environmentally compatible movement of people, goods, and services.

The functional areas within traffic engineering are described as follows:

Traffic Operations is the science of analysis, review, and application of traffic tools and data systems—including accident and surveillance records—as well as volume and other data gathering techniques necessary for traffic planning. It includes the knowledge of operational characteristics of persons and vehicles to determine the need for traffic control devices, their relationship with other traffic characteristics and the determination of safe transportation systems.

Traffic Design consists of the design of traffic control devices and roadway operational design. Operational design concerns the visible features of a roadway dealing with such roadway elements as cross sections, curvature, sight distance, channelization, and clearances; and thus it depends directly on the characteristics of traffic flow.

Traffic Planning includes the determination of personal and freight travel patterns on the basis of engineering analysis of the traffic and demographic characteristics of present, future, and potential land use plans. The determination of these patterns assists in the second step of traffic planning: formulation of recommendations for transportation systems and networks of roadways.
Traffic Engineering Research includes the investigation of theoretical and applied aspects of all areas of traffic engineering to develop new knowledge, interpretations, and applications. Research areas include hypothetical testing; development of traffic hardware; theory formulation; and methods of analysis, synthesis, and evaluation of existing phenomena and knowledge.

The traffic engineering profession has been growing and expanding its horizons for the past 70 years. As each decade brings a shift in professional activities to respond to technological advancements, the engineering field needs to address new areas. This publication covers activities that are probably not covered in the above definitions. Accordingly, the definitions will change over time as the profession meets the public’s need for transportation.

**ITE’s Role**

ITE is an international educational and scientific association of transportation and traffic engineers, transportation planners, and other professionals 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 all modes of transportation. This is accomplished by promoting professional development of members, supporting and encouraging education, stimulating research, developing public awareness, exchanging professional information, and maintaining a central point of reference and action.

ITE was founded in 1930 and continues to serve as a gateway to knowledge and advancement through meetings, seminars, and publications for members, the engineering profession, and the public. The membership is composed of 15,000 individuals working in 80 countries. ITE’s more than 80 local and regional organizational units and more than 90 student chapters provide additional opportunity for information exchange, participation, and education. The vision of ITE, as approved by the International Board of Direction, is stated:

To be the organization of choice for individual transportation professionals responsible for meeting society’s needs for safe and efficient surface transportation systems.

ITE’s purpose is twofold:

- To enable engineers and other professionals with knowledge and competence in transportation and traffic engineering to contribute individually and collectively toward meeting human needs for mobility and safety.

- To promote the professional development of its members by supporting and encouraging education, stimulating research, developing public awareness, and exchanging professional information.

ITE’s programs include publications; standards development; technical committee research and reports; professional development seminars; training; and local, regional, and international meetings.

This *Handbook* published by ITE, is provided to the membership, other professionals, and interested persons to further the objectives and purposes of the transportation profession. The publication has been developed and prepared by ITE members and other selected authors to present the latest information on the specific subject areas. Additionally, a group of members has reviewed the material to ensure that it is current and accurate relative to professional practice.

**Scope of the Publication**

Members of the traffic engineering profession, other professionals, and laypersons seeking to understand traffic engineering issues have relied on the *Traffic Engineering Handbook* for information on the state of the art of established practice in traffic engineering. This publication represents the Fifth Edition, providing significant and long-term documentation of ITE’s achievements. The First Edition, published in 1941, was the first book ever dedicated to the subject of traffic engineering. Editions in 1950 and 1965 expanded the knowledge and applications in the field. The 1976 and
1982 editions were combined into one publication entitled *Transportation and Traffic Engineering Handbook*, reflecting the profession’s expanded focus on all modes of surface transportation. The 1992 editions once again provided separate publications on traffic engineering and transportation planning, because the scope of material to be covered was more than ample for two publications. Although this is the Fifth Edition of the *Traffic Engineering Handbook*, it represents the seventh ITE publication that addresses traffic engineering.

The purpose of the publication is to collate, in one volume, basic traffic engineering information as a guide to the best practice in the field. It provides a day-to-day source of reference on the principles and proven techniques in the practice of traffic engineering. A number of other publications are referred to as resources for more detailed information. It is expected that the practicing professional will review these other publications for more detailed information.

The material presented herein is not intended to serve as a statement of a standard or recommended practice in the profession. Other documents should be reviewed for that purpose. The material serves as a guideline for professional traffic engineers to use with the application of engineering judgment in their daily activities. Although the publication is not a textbook for higher education in basic or advanced traffic engineering, it has frequently and appropriately served as reference source for the education community. Each chapter includes a list of publications that should be consulted for specific reading in the subject area.

This *Handbook* has omitted some material included in previous *Handbooks*, and also covers new material. For the first time in many years, the publication does not extensively address the *Highway Capacity Manual*. It was assumed that anyone working in that specific area would have the most recent Transportation Research Board publication, available software, and training to deal with capacity problems in detail, so little need exists to summarize that information. The information on traffic studies has also been omitted because ITE publishes a complete reference on this subject. Roadway lighting is not addressed in this edition; lighting design has become a specialty design area, and available training and software provide more complete coverage than could be offered in a single chapter of this handbook. The previous coverage on legal liability has been omitted because the ITE Expert Witness Council is currently developing an *Expert Witness Information Notebook* to provide detailed information on this subject. This notebook will be available as a separate publication through ITE.

New chapters have been added on statistics, public contact, traffic calming, and access management. The orientation of the text is toward providing additional information with a cross-reference to a major publication that contains more details. There is also an attempt to provide essential information and data frequently used by traffic engineers practicing in smaller jurisdictions.

**The Relationship Between the Handbooks**

Concurrent with the preparation of this fifth edition of the *Traffic Engineering Handbook*, the preparation of the second edition of the *Transportation Planning Handbook* is also under way. As stated in the introduction to the *Transportation Planning Handbook*:

> Its purpose is to summarize typical practices and characteristics of transportation use to serve as a basic day-to-day reference on proven techniques and study procedures in the practice of transportation planning.

The *Transportation Planning Handbook* primarily addresses the planning and administration of transportation facilities and systems rather than the operation, design, and management of facilities described the *Traffic Engineering Handbook*. A certain amount of redundancy occurs between the handbooks, as is necessary and desirable, but the editors have made a concerted effort to remove contradictory information and make each publication complete in itself. The *Traffic Engineering Handbook* addresses the details of the traffic engineering functions, while the *Transportation Planning Handbook* includes a broader range of subject matter pertaining to transportation in general.
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