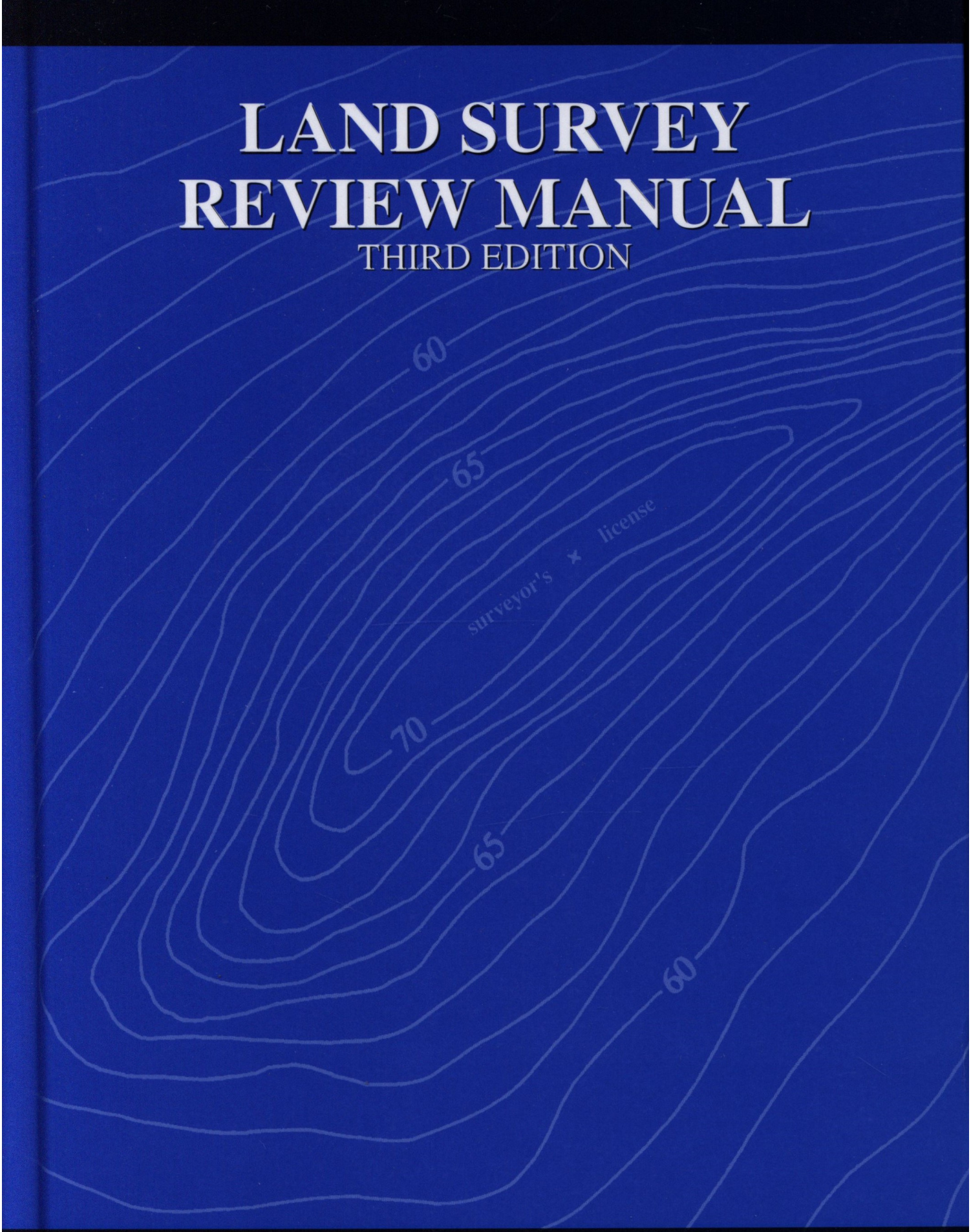
LAND SURVEY REVIEW MANUAL

THIRD EDITION



R. B. BUCKNER

LAND SURVEY REVIEW MANUAL

by

R. B. Buckner

First Edition 1991
Second Edition 1993
Third Edition 2000

This book represents information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission, and sources are indicated. A wide variety of references are listed. Every reasonable effort has been made to give reliable data and information, but the author and publisher cannot assume responsibility for the validity of all material or for the consequences of their use.

Printed and bound in the United States
10 9 8 7 6 5 4 3 2 1

Library of Congress Cataloging-in-Publication Data on File.
ISBN: 1-57504-157-X

PREFACE TO THE THIRD EDITION

The purpose of this book as a reference manual for students and practitioners and as a study manual for licensing exam preparation has remained unchanged from its original intent in the first edition. In the second edition, revisions were made to a section on state plane coordinates to better reflect the results of the NAD83 readjustment of the North American Datum. Other updating was done at that time and some minor mistakes were corrected.

While the first edition was being written, the National Council of Examiners for Engineering and Surveying (NCEES) was completing its third job analysis (1992) to determine the scope of land surveying and the content of surveying licensing exams. Since then, the NCEES has completed a fourth job analysis (1998). The second edition explained the exam content and format after the 1992 job analysis. This third edition explains, in Appendix A, the exam content and format based on the 1998 job analysis. This edition also has an expanded Appendix B on preparing for and taking exams, additions being made primarily in the analysis of questions section. Other than the revisions in these two appendixes, there are no significant differences between this and the second edition. Appendix C, on suggested references, was not revised other than adding one reference and editing some aspects. Basically, the same books are recommended, except that later editions are available for some of them.

This manual emphasizes surveying practice. The academic subjects added to the NCEES Fundamentals of Land Surveying exams in 1999, such as basic sciences, computer operations, and business management are either not covered in this manual or are covered only indirectly through certain related subject matter. It must be realized that most of these subjects are best learned in a college degree program and it would require another manual of compar-able length to this one to review them in even an elementary way.

Most of the questions in this manual are designed to force the reader to think. The questions may seem more difficult than the average NCEES sample question and those on actual licensing exams. This design has proved to foster learning and better prepare the reader for the practice of surveying and passing exams. As part of this attempt to stretch the reader, five choices of responses have been retained in the questions, even though NCEES questions have only four. It is felt that five responses provide more depth and challenge.

It is strongly suggested that licensing exam candidates read Appendixes A and B before studying the rest of the book. If frequent reference is made to the discussion on analyzing questions, in conjunction with studying the question answers and solutions, maximum skill in reading and analyzing questions will be gained. Another strong suggestion is to focus on learning the italicized terms.

B. Buckner
August 2000

PREFACE TO THE FIRST EDITION

This manual reviews the professional practice of land surveying in the United States, as reflected by typical content of land surveying registration exams and as broadly practiced by many surveyors. The text discussions are mostly in a review or summary style, although the author could not resist the temptation to explain, teach, and develop certain subjects -- particularly those felt not to be covered satisfactorily in other books. The reader may sense the review style in the beginning chapters, and a transition in later chapters to deeper and more complete explanations and definitions. The material in the early chapters has been written in a way that assumes the reader will often refer to available textbooks where ample sketches and derivations are presented. However, the reader may discover that many of the presentations, especially in the later chapters, may explain and clarify certain subjects without the need to consult many other references. Chapters 5 and 6 can stand alone as treatises on the subjects presented, without the need for many outside references.

This manual has a primary purpose of providing review for individuals preparing for land surveying licensing exams. It is also intended as a review for licensed surveyors, a reference source for students, and a summary of the profession of surveying for nonsurveyors and prospective surveyors. The format is unique. Following the review of each subject, multiple choice questions and problems are given. At the end of each chapter, the questions and problems are explained and/or solved. These explanations often have additional teaching points which add to the text review. The most unique feature is discussion of the "logical distractors" in the multiple choice questions. The purpose of this is to not only provide the reader an opportunity to learn from the "wrong" answers and analyses, but also to develop skills in reading and analyzing multiple choice questions. In the experience of the author, such skills are nearly as important when tested as knowing the material on a subject. Not all of the "wrong" solutions to numerical problems are given, but enough are so that the reader can learn from common mistakes and better understand how to analyze problems. These points are further discussed in Appendix B.

Readers may approach study and use of this manual in at least three ways: (1) Ignore the multiple choice questions and simply use it as a topical reference manual on land surveying, (2) Ignore the text portions and use the multiple choice questions as samples for self-testing, (3) Read the text material, attempt the questions (in either order), and thoroughly study the solutions and explanations. For anyone already licensed as a surveyor or not interested in pursuing licensing, the first approach might be the best. For college students, some variation of the second and third approach may be useful. For anyone

studying for licensing exams, the third approach is recommended. Additional suggestions for using the manual for exam review are given in Appendix B.

The style of multiple choice questions follows that used by the National Council of Examiners for Engineering and Surveying (NCEES) for the Fundamentals of Land Surveying (FLS) and Principles and Practice of Land Surveying (PLS) exams. The subject matter of the text and the questions and problems embraces the tasks and knowledges tested on these national exams, and much of what is likely on many state surveying licensing exams. There may be a slight emphasis on the FLS exams, but ample depth is also present for PLS exam preparation. No questions in this manual were taken from any past licensing exams, nor were any exams used as reference material. Any similarity is purely coincidental in that both the subject and the question style is the same.

Chapter 1 reviews the mathematics and other concepts and definitions basic to surveying. Chapter 2 reviews the mathematics as applied to land surveying practice. Chapter 3 reviews field measurements, field practices, and instrumentation. Chapter 4 is a review of several technical applications of surveying usually practiced by land surveyors to some extent. Chapter 5 is a rather plush review of most of the topics the professional property surveyor and boundary analyst encounters. Chapter 6 is a coverage of the land subdivision and platting process. These last two chapters, in particular, have been carefully developed and researched so as to include explanations of subject matter which is often difficult to understand or find clearly presented in other references. Although some of the material in Chapter 6 may go beyond what is covered on licensing exams, it is all felt to be important for appreciating this broad area of subdividing and developing land. The appendixes each add something for the licensing exam candidate or student. Appendix A reviews the NCEES exams. Appendix B adds explanation and a structured way to approach reading and analyzing multiple choice questions and preparing for and taking exams. This should be helpful for students or those preparing for examinations of any kind. Appendix C is a list of references, most having brief annotations to guide the reader in selection. This list should be useful to practitioners and students, as well as licensing exam candidates. The exam-taking aspect, as well as the practical aspects of surveying, are emphasized at every opportunity throughout the text. Underlying most of the presentations is an attempt to stimulate interest in the profession of land surveying and a desire to learn more about it.

From start to finish, the author has attempted to "paint a picture" of land surveying, to present what is important to understand for practicing the profession in a responsible and knowledgeable way. As a minimum, it is hoped that the reader will gain an appreciation for the depth and scope of the profession of land surveying, and a deep respect for it once the picture is studied and experienced.

B. Buckner
August 1991
Johnson City, TN

CONTENTS

ACKNOWLEDGMENTS

The author wishes to acknowledge the other authors whose works he has studied, the many surveyors with whom he has been acquainted, and thousands of college and seminar students who have shared their ideas and experiences. All of these have directly or indirectly contributed to adding details and depth to this book. Individuals associated with the National Council of Examiners for Engineering and Surveying are thanked for their help and cooperation in furnishing information related to the examinations, the results of the 1990-91 task analysis of the surveying profession, and changes to result from the analysis. Their timely responses helped make this manual up-to-date and accurate regarding the examination formats and content.

Roy Minnick, owner of Landmark Enterprises, Supervising Boundary Determination Officer of the California State Lands Commission, and fellow author and teacher, proofread the important Chapter 5 on boundary law and property surveying. Dr. Marian Clark, a friend and teaching colleague on the surveying faculty at East Tennessee State University, proofread Chapter 4 and other parts of the book. Mark Williams and Mike Lewis, students in the Bachelor's degree program in surveying and mapping science at ETSU, checked the problems and proofread Chapters 1, 2, 3, and 6. The many suggestions from these people helped significantly to improve the manuscript and to correct various mistakes.

A special thanks is extended to Dr. Teresa Haynes, computer scientist and mathematician, who led me through the preparation of this manuscript on the word processor, typed three of the chapters plus the equations and tables, proofread most of the manuscript for style and grammar, and gave unwavering encouragement throughout the writing process.

CHAPTER 1

BASIC SURVEYING AND MAPPING CONCEPTS

1-1 Geometry of the Earth

The earth is round. (Any problems or conflicts so far?) The basic shape of the earth is an oblate spheroid of revolution, the length of the equatorial axis being approximately 27 miles greater than the polar axis. The average value of the earth's radius used in the U.S. is 20,906,000 feet.

Positions on the earth are defined by *latitude* and *longitude*, both being angular measurements. The 0° origin for latitude is the equator. Latitudes increase to 90°N and 90°S at the north and south poles. The 0° longitude goes through Greenwich, England. These values increase to 180° E and W.

Vertical positions are referred to some reference surface (usually "sea level" as zero) and are positive if the points are above this reference. A *datum* is a reference surface used in leveling. Datums can be arbitrary but are usually referred to sea level. This surface is what geodesists commonly call the *geoid*. The geoid is a surface which is everywhere perpendicular to the plumb line (vertical or direction of gravity).

In geodesy, positions on the earth are given on the spheroid, which is a mathematical surface approximating the geoid. After the most recent readjustment of the North American Datum (NAD 83), an International Ellipsoid was adopted for use in the United States. Geodetic latitude and longitude are coordinates on this ellipsoid, which may differ slightly from coordinates of the same point on the "old" 1927 system since the geometry changed slightly. In any case, an ellipsoid (or spheroid) has a different shape than the geoid, as the latter *undulates* as affected by the direction of gravity. At any location, gravity (the vertical) and a perpendicular to the ellipsoid point in different directions. This difference is called *deflection of the vertical* and is important in precise, geodetic work. It affects azimuths, as well as positions, and is important to consider when converting from astronomic azimuth to geodetic and state plane grid azimuth, for example.

A *level surface* is a surface every element of which is normal to the plumb line. Elevation differences are vertical distances between level surfaces. If a plane is passed through the earth's center, its intersection with a