A GUIDE TO Understanding LAND SURVEYS

THIRD EDITION

Stephen V. Estopinal

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For my father, Eugene

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PREFACE

The first edition of *A Guide to Understanding Land Surveys* was published in 1989. The original work was intended to present vital information and insight to users of Property Boundary Surveys. In the intervening decades, advances in the science of measurement, computation, data management, and other disciplines have provided Land Surveyors with tools that are so powerful that they defy description.

Advances in science have resulted in the modern, well-prepared Boundary Survey of today. These Surveys and the Land Survey Plats they produce are far superior to that which was commonly presented in the late 20th century in many ways. The conceptions that the general public has about modern Land Surveys have not kept pace with the changes.

Misunderstanding and misconceptions about Land Surveys have been compounded by these great advances, not alleviated. The airways are flooded with advertisements touting simple and easy-to-use navigational devices. Anyone with an Internet connection can visit multiple web sites that provide aerial photography, maps, and a host of geographically based information. The general public has been given the impression that science has simplified surveying to merely navigating to the corners as if the locations of, and the distances between, all property corners were known.

Measurements of distances, directions, and location are but tools that the Land Surveyor uses. A Surveyor determines a precise location in order to *begin* the survey, not as an end in itself. Highly accurate measurements of angles and distances are used by the Surveyor to document boundary locations and assist in the recovery of property corners. Precise measurements form a foundation for the Surveyor's work, not an end.

This book continues to be a valuable source for land title attorneys, paralegals, realtors, government agents, and others who use the information gathered and presented by Land Surveyors. These professionals will find this work very useful in deriving the maximum benefit from the Survey Plats that they review in performing their duties.

Dispelling misconceptions and incorrect assumptions that exist in the general community will do much to reduce conflict and unnecessary litigation. In that regard, this book has great value. The reader will also be provided with an overview that will go beyond merely dodging pitfalls. The broad and general concepts presented in this book will also assist the reader in evaluating survey information and *communicating* his or her informational requirements to the Professional Land Surveyor.

Communication is perhaps the most important aspect of contact between users of Land Surveys and the Professional Land Surveyor. The Professional Land Surveyor will also find this book to be most useful in developing firm and clear relationships with their clients.

Burnside, Louisiana
May 2008

STEPHEN V. ESTOPINAL

A GUIDE TO UNDERSTANDING LAND SURVEYS

CHAPTER 1

PURPOSE OF THE BOOK

This book was developed to meet the needs of attorneys, abstractors, realtors, land planners, entrepreneurs, and others who must use and evaluate the work of professional surveyors. Boundary survey plats or maps, property maps, topographical maps, survey reports, and property descriptions, among other things, are all products of the professional surveyor. Rapid increases in technology, data availability, land values, community/regional planning, and the modern propensity for litigation have meant that more and more nontechnical individuals have begun to use and rely on increasingly complex and technical land information.

The most significant of the modern advances in Land Information Systems (LISs) or Geographical Information Systems (GISs) has been the Internet. Virtually any tidbit of information that can be associated with a geographic position can now be made available to anyone with an Internet connection. Anybody and everybody who desires to explore land uses, owners, zoning, regulations, conditions, and so on can now have that data at their fingertips. Municipal, state, and federal archives; agencies; and other organizations maintain web sites where the visitor is free to explore databases without restriction or *professional assistance*. Without a clear understanding of the source, reliability, and *intended use* of that data, an unsophisticated user can cause more harm than good. Indeed, there is a real danger that the ease with which this information is obtained will facilitate misapplication of that data while at the same time circumventing professional assistance.

As an example of the sort of confusion that can result from misuse of the sophisticated GIS data banks available today, an electronic database may be compiled for the intended purpose of identifying properties for appraisal and taxation. This data would typically be presented on the Internet in the form of a map developed from aerial photography. The boundaries on that map were created by technicians who reconciled fence lines and other visible features with whatever deed documentation was available. A user might access that map and, because the computer allows it, obtain distances, directions, and quantities of the real property parcels as presented in that graphic representation. While presented by the computer as precise, the distances, directions, and acreage obtained in this example would be far from accurate.

The location, configuration, and description of real property parcels are just some of the multitude of important geographic questions people typically have. The recovery, documentation, and interpretation of this data are the professional specialties of the Land Surveyor. Once a person realizes the necessity of obtaining the services of a professional surveyor, they may have difficulty in communicating to the surveyor just what it is they need. From attorneys to private citizens, the word *survey* has many different meanings. For example, a determination of boundary location for the purpose of erecting a fence is a "survey." The determination of the elevation of a building for the purposes of obtaining flood insurance is a "survey." The recovery or remonumentation of the boundaries of a parcel of land for the purpose of an exchange of title is a "survey." Each of these examples is called a "survey," yet the scope of work, the responsibilities of the surveyor, and the *expectations* of the persons ordering the "survey" are all very different.

A better basic understanding of just what a surveyor does and does not do can make the difference between complete service and unsatisfactory results. Much litigation, confusion, and aggravation can be traced to a misunderstanding between the surveyor and the client. It is essential that the surveyor be informed of the exact purpose of the survey being requested. The completeness of the surveyor's report, the extent of his or her research, the areas examined, and other pertinent work vary greatly, depending on the type of survey that is being conducted.

Compounding the problem is the fact that the person requesting the services of a Professional Land Surveyor may not be the person using and interpreting the results of the work. This "third-party" use of a surveyor's maps or reports is rife with dangers, not the least of which happens when the user assumes that the surveyor did what the user wanted done when in reality the surveyor carried out the client's orders. For example, an owner of a vacant urban lot may request that a surveyor recover only the boundaries of that lot. Easements, servitudes, building restrictions, and other important title restrictions that impact on the enjoyment of that lot do not affect the boundaries of that lot. The surveyor would then recover or mark the boundaries and issue a report in the form of a drawing to the owner, showing the dimensions of the lot and the locations of the boundary markers. If, at a later date, the owner were to sell the lot, he or she could present this drawing to a buyer. The buyer, having no knowledge of the limited request of the previous owner, might then rely on the drawing produced as if it reflected all of the information about easements, servitudes, buildings, and other facts important to the buyer. The resulting lawsuit would charge that the surveyor neglected to perform the extensive work that the buyer needed when he or she complied with the limited request of the owner.

The grief, aggravation, and expense resulting from the previous scenario could easily be avoided if the buyer or the buyer's attorney confirmed that the drawing presented to them contained all of the information that they wanted to know. Third-party situations like this one have resulted in so many lawsuits that many surveyors now place explanations of the extent of the work done by them in producing the survey plat directly on the plat. Some state registration boards have even adopted a regulation or "standards of practice" that require such statements.

The Land Surveyor is an investigator—a detective more than anything else. The subject of the investigation is the location of the boundaries of real property. In the pursuit of the evidence necessary to determine, with relative certainty, the original location of a particular boundary line, the same rules of evidence apply as in any civil court. Surveyors not only measure angles and distances, but also perform extensive records research in private and public files in an effort to reveal as much information as possible about the *location of boundaries*.

This extensive research does not normally include many other factors involved in property rights. Title insurance is a different service from a boundary survey, although most title insurance policies include the requirement that a boundary survey be performed. Easements, servitudes, building restrictions, setbacks, or side clearances for new construction, flood zones, and regulatory zoning, among other things that limit the use and enjoyment of real property, are not essential to the recovery of boundaries. If you wish to have all, or any, of these items shown on a survey plat, you must tell your surveyor.

The surveyor will report evidence of these factors limiting the free enjoyment of a real property parcel whenever it is discovered in the normal course of boundary recovery. If an original subdivision plat includes an easement, the surveyor will normally report it. If an easement is granted separately from the subdivision recordation, the surveyor may not have the occasion to discover it. The records search by a Land Surveyor takes a much different route than that of a title examiner. Provide the surveyor with the complete title record if you wish it to be shown on the survey plat. Otherwise, a boundary survey will result in the recovery and a report (plat) on the real property limits of a particular parcel *and nothing else*.

This book is intended to bridge the ever-widening gap between the users of land boundary information and the producers of that information—professional Land Surveyors. To that end, the information in this book will be only as technical as necessary to convey general concepts and will be presented in such a way that every reader, from one experienced in the use of land boundary information to the novice, will gain a better understanding of the profession of land surveying and the products of that profession. The early chapters of this book provide a very important background to understanding real property surveys because they deal with the root causes of confusion and misunderstandings concerning boundary surveys and the survey plats or maps that are produced as a result of surveys.

Real property laws, traditions, and practices vary throughout the United States. This book will not attempt to address the specific details of every state but will describe in a general setting the common facts found throughout the United States. The reader is advised to determine how the particulars of real property laws and the principles and practices of boundary surveying in his or her area vary from the general concepts addressed in this book. Most local surveyors or professional surveying organizations are very happy to assist anyone in familiarizing themselves with local practices.

A large portion of this book is devoted to the writing, reading, and interpretation of legal descriptions of real property parcels. That portion will be devoted to the mechanics of legal descriptions and will not presume to advise the user on the appropriate form of legal description to use for a particular situation but, rather, will tutor the reader on the geometric and semantic aspects of describing real property parcels. The great differences between those regions of the United States known as "metes and bounds" areas and United States Public Land Survey (USPLS) areas will be explored in depth.

This book will serve both as a handy, daily reference guide and as a tutorial text. The reader may want to refer to portions of this book when ordering survey work or when evaluating survey plats, legal descriptions, or reports already received. Although this book will improve the reader's understanding of land surveys, it will not make the reader a Land Surveyor. Many highly technical aspects of measurements, computations, details, and equipment are only lightly referred to, if at all. Sophisticated research and recovery techniques, so vital to the recovery of boundaries, would make a book in itself. Your Professional Surveyor is the expert you must rely upon for these skills.

This book will not serve as a substitute for qualified legal assistance in the interpretation of real property rights or transfers. The survey plats and problems used as examples in this book are highly simplified versions of their more complicated actual counterparts. The laws concerning boundaries and real property rights differ from state to state and change over time. Some general rules are mentioned, but these are not to be interpreted as universal laws. The attorney is the professional who should be relied upon for the status of real property law in a particular area. The reader should make note of such regional variations as may exist when he or she is using this book.

CHAPTER 2

REAL PROPERTY ON A ROUND PLANET

2.1. OWNERSHIP

Land cannot be owned, at least not in the same sense as physical objects are owned. People cannot carry their land with them to new locations. Land cannot be manufactured or destroyed. If one were to excavate a great hole in a property parcel, the land might be rendered useless, but the real property parcel would still exist. "Reclamation" of submerged land is not manufacturing land but simply altering the surface condition of an existing area. The "sale" of a real property parcel does not result in a giant cookie-cutter stamping out of a hunk of land to be turned over to the purchaser. One cannot tour the country collecting scraps of land and assemble a ranch in California.

Real property ownership is not the ownership of land; it is the designation as the authority to control an area. It is the ownership of "rights." The right to build upon, improve, inhabit, cultivate, deny access to others, and countless other rights are what is owned.

Mankind is not the only species to demand authority or control over a land area. Territorial creatures, great and small, impose their authority over their range by force. The dawn of civilization brought with it the concept that people could associate themselves with a group larger than a family or tribe and collectively defend their territorial authority. City-states and then national states were formed around the concept that individuals within a state would contribute to the protection of the state in return for the "right" to inhabit, cultivate, use, and enjoy the land.

All of these rights are intangibles and flow from the "sovereign" or governing authority. The laws enacted by national governments determine the extent of personal real property rights. It is no coincidence that national governments that maximize individual real property rights over collective control generally prosper and those that restrict individual rights in favor of central control do not.

Peoples who have found themselves to be without a defending force are routinely forced from the land by those who do. It is the armed forces of a national government that establishes sovereignty and defends the laws that dictate which rights may be acquired by individuals in a certain area.

2.2. TITLE

The Constitution, laws, and statutes of the United States of America and the individual states allow the assignment of "real property" rights to private persons. Those persons entitled, under the law, to exercise the rights of real property ownership are said to "hold title" to a land parcel. It is these rights that are transferred in the sale of "land." Persons may gain "title" to real property through written and unwritten transfers. However, only recorded, written title transfers are merchantable.

The collection of papers, recordings, and other documents that describe a transfer of the titled rights to a real property parcel are often referred to as the *title*. In fact, such documents are only evidence to the lawful assignment of title. Title, the collection of real property rights, is a concept in law and therefore incorporeal.

2.3. BOUNDARIES

Real property boundaries are the invisible limits of the intangible rights that constitute real property ownership. Corporeal possessions have clear limits. Unless there has been a terrible accident, a person has no difficulty discerning where her or his car ends and another's begins. A person can exit his or her car without entering another's.

This is not the case with real property. The limits of the rights of ownership cannot be seen. Physical evidence as to the location of that limit may be obvious, but the limit itself is an invisible and dimensionless concept. One must be on one side of a property boundary or the other. As soon as one crosses the limit of one set of rights, another set of rights is entered.

2.4. DEED

A deed is the written instrument that describes the assignment of the rights that are "owned" and the geographical limits of that assignment. A deed is not the same as a title, although the words are often used interchangeably. Although the limits of the rights of real property ownership are invisible, they must be identifiable. Every deed must communicate what rights are owned and where the boundaries or limits of those rights are. It is folly to attempt to transfer rights in real property without adequately identifying and communicating the location of the limits of the rights conveyed.

The Professional Land Surveyor is charged by society with the responsibility to recover, monument, quantify, and document the imperceptible limits of the intangible rights that constitute real property ownership.

2.5. IDENTIFYING BOUNDARIES

There has always existed the need to identify and to communicate locations on the surface of the earth. Stone Age men and women could relate to localities only by naming mountains, rivers, or other features of the terrain and then specifying a locality as being near a certain feature. This first use of landmarks required that the receiver of the information be as knowledgeable about the terrain as the giver.

Artificial landmarks were, and are, also used to identify boundaries. Territorial animals, including humans, mark their territories. Although this was adequate for identifying locations to a person who was at the boundary or familiar with the territory, the advent of long-range travel, especially sea travel, required a method of identifying locations that did not rely exclusively on terrain features. The development of the concept of the assignment of real property rights by law, instead of physical occupation, required a method of identifying locations in a way that could be written, recorded, and communicated between parties, even people who are in other locations.

2.5.1. Geography

Geography and real property boundaries both require the communication of locations, distances, and directions. The glaring difference between the two is that geography can be directly measured, but real property boundaries can only be defined.

Although the question of defining real property boundaries was adequately addressed early on through the use of artificial marks and other references to physical features, geography and navigation required advances in math and science that has taken centuries to perfect. Real property boundary descriptions have, generally and often imperfectly, followed the improvements in geography and navigation. Slowly, both are beginning to solidify behind the same scientific foundation. The history and application of that foundation is fundamental to understanding Land Surveys.

As the earth spins in orbit around the sun, its motion can easily be detected by any observer using no other instrument than the human eye. Unlike the moon or the sun, the stars clearly reveal the constant, circular motion of the planet. It was this motion that led to the development of today's worldwide system of identifying points on the surface of the earth.

In spite of the fact that some of the ancient observers may have even believed that the world was flat, the direction to the center of the apparent circular celestial motion was the very first geographical standard reference adopted by those attempting to describe real property boundaries. That standard direction of reference is called "north." This standard has survived for centuries and remains in use to this day, simply because it can be easily and precisely determined anywhere on earth.

2.5.2. Latitude

Ancient seafaring societies noticed that the motion of the stars was not only circular but also regular and predictable. One of the earliest observations was that particular stars were known to pass directly over the same place every night. Many societies came to identify stars by the earth locations or "latitudes" that the stars would seem to track. The Polynesians, to this day, identify certain stars by which island or island group those stars pass directly over. The reverse is also true: a certain location can be identified by the star that passes overhead.

In reality, the apparent motion of the stars is the result of the spinning of the earth. The apparent center of rotation that the ancients observed is an indication of this axis of rotation. "North" is so universally detectable that it was inevitable that the system of identifying locations that developed used this axis as the reference base. Figure 2.1 shows how the concept of "latitude" first developed. Note that the angle measured to determine the latitude of the observer's location is actually the angle between a horizontal line tangent to the level surface of the earth

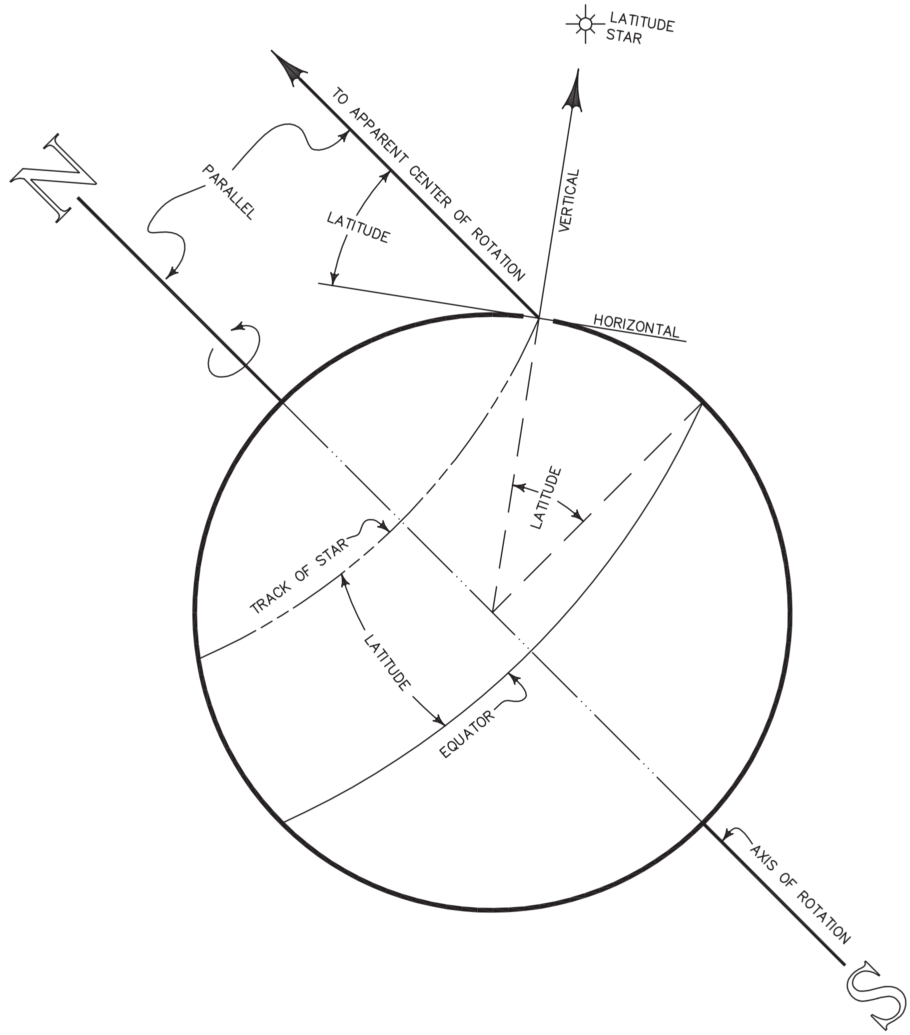

FIGURE 2.1

and the axis of rotation. Points on the surface at which the same angle or latitude is observed can be connected to form a curved line circling the earth.

These connections of points on the surface of the earth of equal latitude are called “latitude lines.” By definition, latitude lines are east–west lines, and, as shall be shown later, of all the latitude lines, only the equator (zero degrees latitude) is a “straight” line. The latitude of a particular point can be used as a measure of the distance north or south of the equator and is so easily measured that early explorers often sailed north or south to the latitude of their destination and then east or west to reach shore. This convenient measure of north–south distances often caused early maps to be quite accurate in reporting latitudes but woefully inaccurate in reporting east–west dimensions.

2.5.3. Longitude

The axis of the earth's rotation is, therefore, a naturally occurring reference that can define directions on the surface of the earth, as well as distances in a north–south direction. In order to identify a particular point along a line of latitude, the concept of *longitude* (shown in Figure 2.2) was developed.

Just as latitudes are a contiguous series of points with a common factor (the measure of the angle between the earth's axis and the horizon), longitudes are a series of contiguous points with the common factor of being aligned along the apparent axis of rotation. These north–south lines are sometimes referred to as "meridians" when they are used to define other lines or directions. Unlike latitudes, the reference for longitudes had to be arbitrarily chosen.

Throughout history many locations have been used as the origin of latitudes depending upon the map maker's preferences. Today, most of the world has accepted that zero degrees longitude is defined as passing through a particular point in Greenwich, England, and is called the "prime meridian." Longitudes are used to define or to measure distances in an east–west direction. The combination of a north–south distance and an east–west distance can be used to define a particular point on the surface of the earth. Theoretically, only one pair of latitude and longitude values can be associated with a specific surface point.

Although longitudes are reported in degrees, just as are latitudes, time is the factor actually measured by observers in determining the longitude of a particular location. In order to accomplish this measurement, an observer might note, for instance, that a particular star is directly over the prime meridian at a certain time and that that same star is directly over the longitude of the observer some time after that. The elapsed time is directly related to the distance from the prime meridian to the longitude of the observer. The earth completes approximately one rotation (360 degrees) in 24 hours. Therefore, the ratio of elapsed time to 24 hours is the same as the ratio of degrees longitude to 360 degrees. In actual practice, the stars observed, angles measured, and elapsed times noted are never as direct as this simple example.

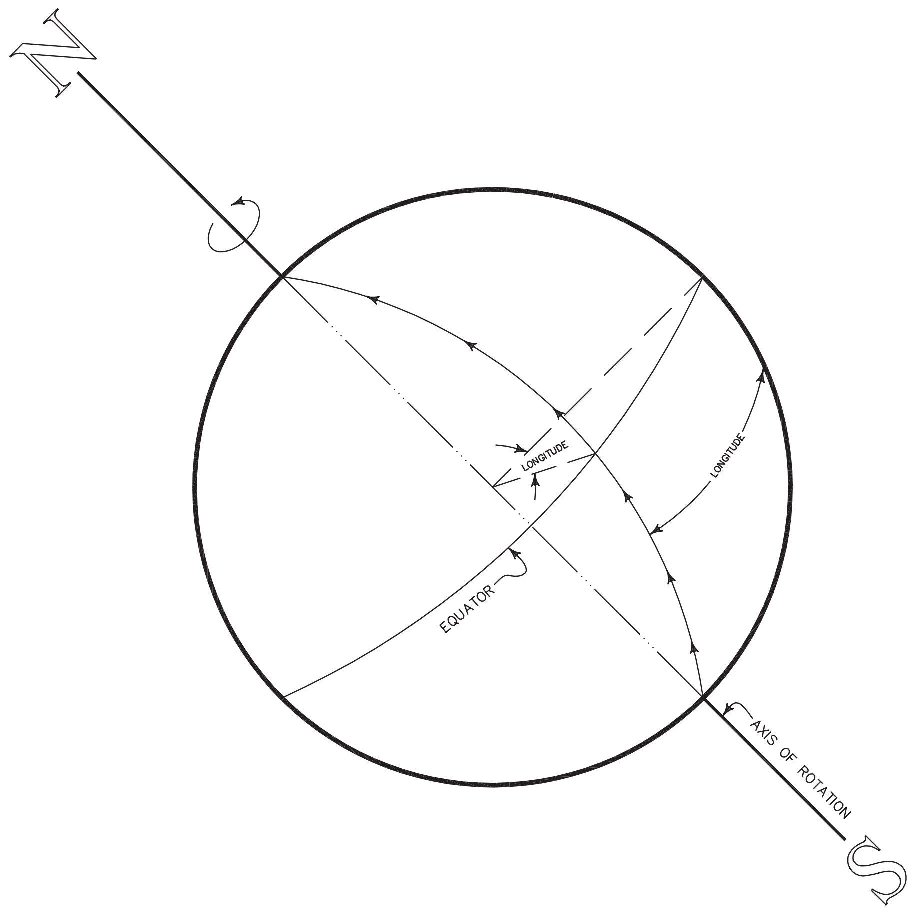

FIGURE 2.2

Latitudes and longitudes are reported as if they were angles measured at a point at the center of the earth, when, in fact, the measurements are of time and of angles and, until the advent of the earth-orbiting artificial satellite, made at the surface of the earth. This would not cause a major distortion if the earth were a sphere with no irregularities of surface or gravity. But precisely because the earth is not a sphere and because the observations are made on the surface of the earth, the shape of the earth and the distortions caused by the irregularities of the surface must be understood in detail. The impact of space-age technology will be discussed at length later.

2.5.4. Astronomic Position

With the first attempt to account for the irregularities of the earth's surface, a method was developed by which all measurements or observations were adjusted to account for elevation above sea level. This method developed a theoretical surface that covered the earth and that was everywhere perpendicular to the pull of gravity. The theory behind this assumed that, if the entire planet were covered with water, the planet would be a perfect sphere. The surface that resulted from this "reduction to sea level" is called a "geoid." The latitude and longitude based on celestial observations used to identify a specific location are called that location's "astronomic position." Astronomic positions are computed based on the geoid surface. Unfortunately, a geoid is not a sphere, nor is it a regular surface.

Gradually, the realization developed that the anomalies of the gravitational forces around the world produced a geoid that was "dimpled" and undulating. Astronomic positions are, necessarily, based on the pull of gravity. Astronomic latitudes and longitudes are not, therefore, perfectly circular curves or perfectly straight lines on the geoid surface. The positions reported by astronomic observations are distorted by the irregularities of the geoid.

Astronomic positions were quite adequate until the methods and precision of measurement became so refined that the irregularities of the earth's shape became detectable. Astronomic positions lack the precise predictability necessary for accurate navigation and mapping. The science of geodesy, the study of the size and shape of the planet Earth, and the science of cartography, the study of mapmaking, have developed methods to reduce the uncertainty inherent in astronomic positioning.

2.5.5. Geodetic Position

The need to compute precise distances between locations of known positions or to compute the position of a location based on distance and direction from a known position requires a regular, mathematically identifiable surface on which computations can be made. The geoid can be approximated by a theoretical shape or model based on regular geometrical formulae. The mathematical shape or model chosen for this approximation is called a "spheroid" or "ellipsoid" and forms a theoretical surface on which the values of latitude and longitude are computed for any earth location.

The latitude and longitude of a location based on an ellipsoid is called the "geodetic position." Imagine that the surface of the earth is transparent and that the surfaces known as the ellipsoid and the geoid are glass bulbs around the center of the earth. A man standing on a high mountain could shine a light straight down. Where that light hit the geoid would be the astronomic position of the man. Where that light hit the ellipsoid would be his geodetic position.

The geodetic position is what is reported for navigational and mapping purposes. For most localities and for many purposes, the differences between astronomic and geodetic positions are not significant. The ellipsoid used in a particular map or in a particular country is usually defined by national or regional statutes. Improvements in understanding the shape and size of the earth has caused the scientific community to redefine the ellipsoid used to create geodetic positions. The most recent change of any significance has resulted in the published geodetic positions of fixed earth locations that in some areas were 30 or more meters different from the old system. The standards for the United States of America and each of the member states will be discussed at length later in this book.[1]

Locations are reported by a longitude west or east of the prime meridian and a latitude north or south of the equator. Longitudes are always less than or equal to 180 degrees. Latitudes are always less than or equal to 90 degrees. The values reported are the apparent distances along the surface of the geoid, in the case of astronomic positions, or the ellipsoid, in the case of geodetic positions.

2.5.6. Flat-Earthers

The spherical reference systems of astronomic and geodetic latitude and longitude are perfectly applicable to defining locations on a planet or, more precisely, on the surface of a spheroid, as shown in Figure 2.3. However, the basic instincts of the human mind and the limited input of our senses tell us that the world is flat. Because the earth is so large compared to the range of our senses, we conceive of the surface of the earth as being two-dimensional. This concept of a two-dimensional surface is reinforced by our use of maps and our insistence on using two-dimensional geometric terms that describe features on the map when we are referring to features that are on the surface of the earth.

Consider the following trip: A woman on a Montana ranch begins a trip by walking due north for exactly one mile, then turns right and walks exactly one mile due east, turns right and walks exactly one mile due south, and then turns right and walks exactly one mile due west

[1] See section 5.6: Advantages of State Plane Projections.

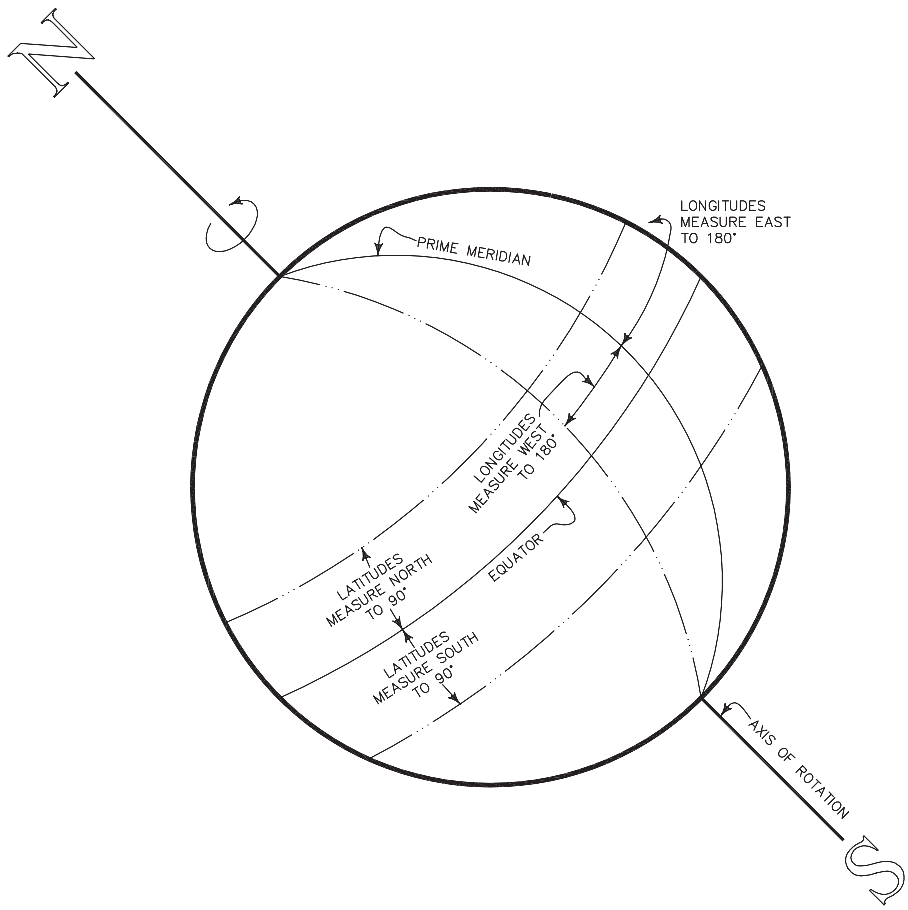

FIGURE 2.3

and stops. The question is, "Where is the woman in relation to her starting point?" If you say that she has returned to her starting point, then welcome to the flat-earth society!

Even after sketching such a trip out on paper, our instincts blind us to the fact that the trip took place on the curved surface of the earth and not a flat surface. The sketch on a sheet of paper is a two-dimensional representation of a three-dimensional event. In spite of discoveries, observations, knowledge, and measurements to the contrary, each of us persists in thinking of the surface of the earth as flat. This "flat-earth" mentality must be overcome in order to begin to understand land surveys and the maps or plats that represent these surveys.

All of this would be academic to most of us if it were not for the concept of ownership. The law recognizes the fact that persons can claim, as personal property, certain rights to portions of the planet. Real property law is that body of law devoted to defining the limits of these "rights of ownership" over portions of the earth. Real property boundaries are imaginary limits intended to define the extent and dimensions of such ownership. This ownership is not limited to the surface of an imaginary spheroid, nor is it limited to the surface of the earth.

The boundaries of real property rights or ownership are imaginary limits created by law in an attempt to control the actual, corporeal use of the land. The professional land surveyor serves as the bridge between the physical limits to the exercise of real property rights on the land and the imaginary concepts of ownership boundaries. The great value often attached to continued enjoyment of real property rights demands *permanence* and *recoverability* of the physical limits of real property boundaries. The boundaries cannot shift with every improvement in the science of geographic measurements.

It is people who must use the land. People are accustomed to straight lines, regular shapes, and consistency in the configuration of real property parcels. Geodetic positions can be defined, but geodetic lines of constant value do not follow straight lines of sight. Real property limits need to be defined and described in a way that is consistent with the flat-earth mind-set of people.

2.6. CORNERS

It is possible to mark a parcel that has straight land line segments on all sides. It is also possible for each of the four sides to be one mile in length. Instead of defining the boundaries of the parcel by marking each step of a walking man, the end points of each side could be marked and the boundary could be defined as a straight land line *between the end land points or corners*.

The desire for regular shapes, parallel lines, and constant directions for straight lines is resolved when the boundaries are so defined. For this reason, as well as others to be discussed later, the vast majority of boundaries in the United States are defined by the location of corners.

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STEPHEN V. ESTOPINAL

CHAPTER 3

GEOMETRY

In order to better understand exactly what it is that Professional Land Surveyors are presenting in their plats, maps, and reports, a closer look at the somewhat esoteric concepts of geometry and geodesy is necessary. Some of the words used in describing boundaries are common geometric terms and have generally accepted definitions that are *very different* from what is meant when these terms are used in real property situations. Geometry is consistent in that the terms used can describe two- or three-dimensional concepts. Maps are two-dimensional drawings, and the geometric terms describing map features are consistently confused with the three-dimensional surface features that the maps represent.

3.1. PLANE GEOMETRY

Consider these basic definitions of geometric terms:

Space—An extent or continuum in which objects can exist and have relative positions and directions.

Point—A specific, dimensionless location in space having a unique position.

Line—A series of contiguous points such that any point in the line is directly adjacent to two and only two other points in the line.

Straight line—Any line in which the route of measure of the shortest distance between any two points on the line lies entirely within the line.

Ray—A portion of a straight line originating or emanating from a point.

Line segment—A portion of a line beginning at one point and ending at another.

Distance—A measure of the separation of two points.

Length—The sum of all of the distances between consecutive points of a line segment.

Surface—Any array of contiguous points, having no thickness, that completely separates two distinct spaces.

Plane—A surface such that the shortest route between any two points on the surface lies entirely within the surface.

Area—The measure of a bounded surface.

Volume—The measure of a bounded space.

Angle—A measure of the relationship of two lines, rays, or line segments.

If one were to restrict the concepts of geometry to the two dimensions of a flat plane, then the three-dimensional terms of *space* and *volume* would be eliminated. The concept of *lines* also changes subtly. Straight lines in a two-dimensional system either intersect or are parallel. The concept of *angles* is rendered much simpler, and the entire system can be modeled quite easily by sketching on paper. There are also one-dimensional systems that are frequently used but rarely recognized as such. One particular one-dimensional system, the deed description, will be discussed at length in Chapter 13.

It is important to keep in mind that, in spite of the fact that one- and two-dimensional systems exist, our world is three-dimensional; therefore, whenever real property is located, measured, defined, or exchanged, a three-dimensional portion of our planet is involved. This fact requires that the geometric definitions already given be redefined to reflect what is really meant when these terms are used in describing real property. In order to assist the reader, when terms in this chapter are used that may confuse the real property definitions and the geometric definitions, the use of the adjective “land” will emphasize the real property definition—for example, “land line,” “land boundary line,” “land point,” and so on when the real property definition is intended. In everyday practice, the adjective *land* is not used.

Anyone who has dealt with real property boundaries, title transfers, or surveys may have noticed that some of the words defined earlier in this chapter concerning dimensional geometry are often used in describing real property. These geometric terms, when used in real property descriptions, are misused in a curious mixing of two-dimensional and three-dimensional concepts. It is very important to understand how these words are misused, or, more accurately, redefined in real property descriptions before an appreciation of just what a boundary survey really is can be reached. The distinctions of what is conveyed, what is physically marked, what is drawn on a survey plat, and what is described in legal instruments are vitally important.

3.2. LAND POINT

An easy definition of a *land point* as used in real property descriptions would be something similar to "a specific location on the surface of the earth." However, it is much more than that. For instance, if a property corner were located on the side of a hill and the hill were removed by earthwork, the property corner or land point would remain. Its location would not be thought of as having "moved," although the surface of the earth would now be several feet lower than the original surface. If, however, a property corner were located in a swamp or a low spot and the land were later filled or leveled, the location of the property corner would not be altered as far as the real property definition of that parcel was concerned. Changes in elevation do not alter the locations of land points.

Figure 3.1 illustrates a real property land point that was marked (monumented) on the earth's surface in 1802. Years of erosion and earthwork have destroyed the monument and have lowered the surface several feet. In 1980, the land point was again monumented at a different location in space, several feet nearer the center of the earth, yet the location of the land point did not change as it is defined in land surveying terms.

What is called a "point" in real property terms is, in geometric terms, a ray emanating from the center of the earth and extending through the surface of the earth, where it is usually marked or defined, and beyond the earth as far as the legal concepts of "air space" and "reasonable control" extend. Real property descriptions call this ray a "point" because humankind's flat-earth instincts and, more importantly, the surveyor's plat depict the real property parcel as being a plane.

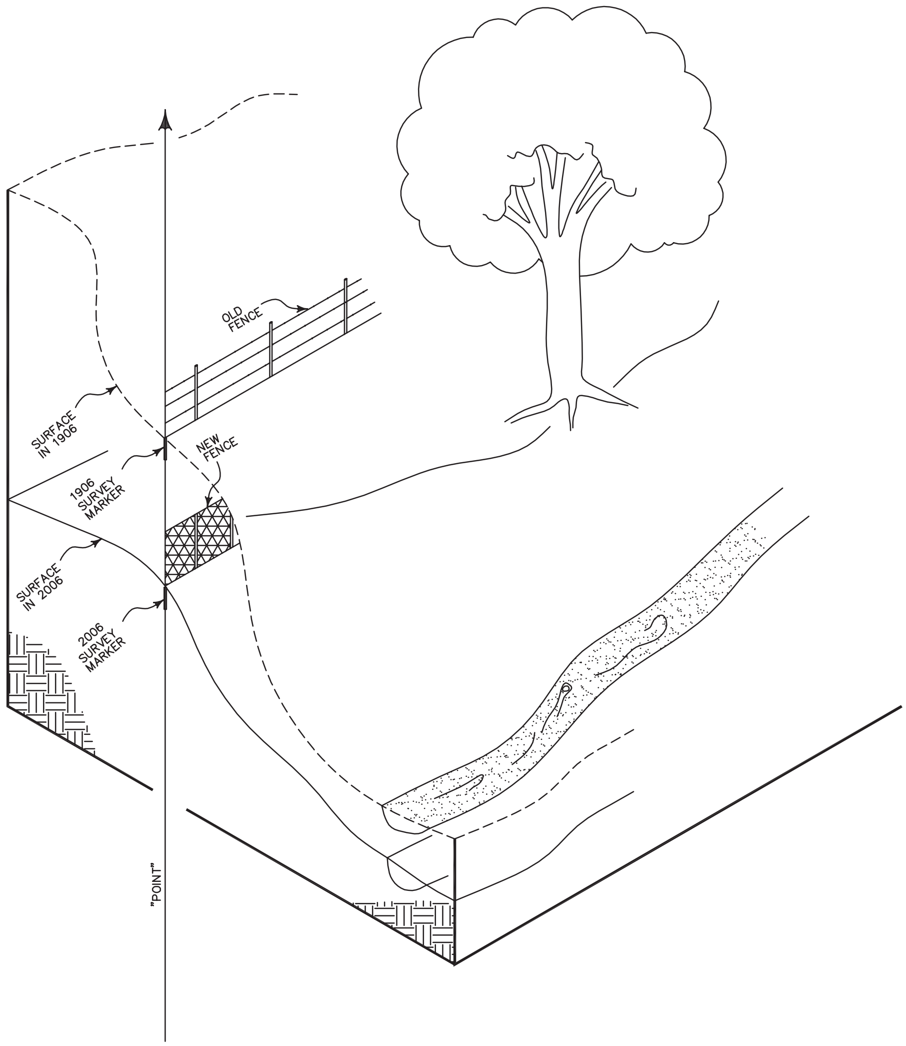

FIGURE 3.1 Land Point

3.3. LAND LINE

In real property descriptions, a "land line" is a series of land points. There are many different kinds of land lines, but the land line most commonly encountered by the layperson is the boundary or property line. Boundary or property land lines define the limits of rights or possession of land areas. Like real property land points, property land lines are not thought of as "moved" or "shifted" if changes of elevation take place. Land lines are imaginary, theoretical limits that have no thickness but do have direction and location. Because land lines are a series of land points, the strict geometric description of a land line is a vertical surface containing the center of the earth.

3.4. STRAIGHT LAND LINE

The direct, line-of-sight route between two distinct locations (land points) on the surface of the earth has been traditionally defined as a straight land line. Historically, straight land lines are marked on the ground by aligning all interior points of the land line between the end land points. Because land points are geometrically rays and land lines are geometrically surfaces, the procedure for establishing a straight land line results in the establishment of a *flat* vertical plane passing through the center of the earth and bounded by the rays that make up the end land points. Therefore, a straight land line is not altered by shifting terrain. A land line may travel up hills, down into valleys, and across rifts in the surface and still be straight. Any ray from the center of the earth that is contained in the plane of a straight line or in the surface of any land line is said to be a "point on the line."

Note that, in Figure 3.2, the surveyor's instrumentman has set up her theodolite such that the land point passes through, and is coincidental

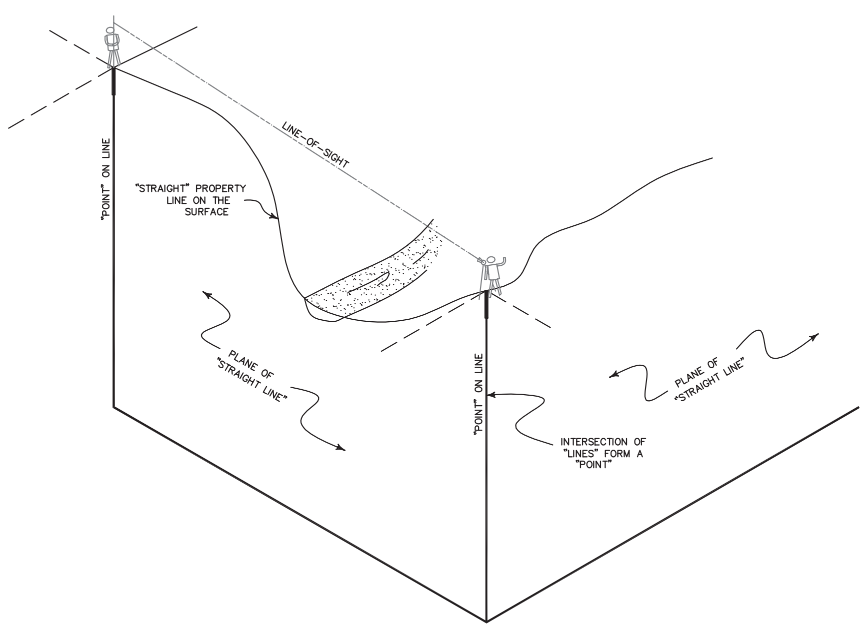

FIGURE 3.2 Straight Land Line

with, the axis of rotation of the instrument (in surveying jargon, this is "occupying a point") and is directing the rodman, who is holding a vertical pole (called a range pole), to a "point on line." The vertical pole will be "on line" when the ray that is the land point passes through, and is coincidental with, the axis of the vertical range pole.

3.5. PLUMB LINE

In the real property definitions of both a point and a line, the concept of "up" and "down" or "above" and "below" were used. Many children's programs deal with these concepts by simple demonstrations. Closer examinations of these instinctive terms have revealed subtle complexities, some of which need to be addressed now.

"Up" is away from the pull of gravity. "Down" is toward the pull of gravity. The pull of gravity is *not* always directly toward the center of the earth but toward the apparent center of gravitational attraction. A line that is everywhere aligned with the pull of gravity is said to be a "plumb line." For most localities on the surface of the earth, the pull of gravity is very nearly toward the center of the earth. The effects of the difference are real, measurable, and, in some rare cases, affect the definitions of the location of real property lines.

3.6. LEVEL

A level surface is a surface such that each and every plumb line passing through that surface does so perpendicularly. The geoid, discussed earlier, is a level surface. "Flat as a mill pond" is a contradictory phrase. On a perfectly calm day, a mill pond is level, not flat. Notice that in Figure 3.3, the level surface ripples or undulates as deflections in the pull of gravity are influenced by irregularities in the earth's landmasses.

3.7. LAND DISTANCES

Now that we see that real property points are geometrically rays and real property lines are geometrically surfaces (a "straight line" being a flat plane), let us examine how "distances"—that is, the separation of two land points—are defined. In geometry, a "distance" is the measure of the separation of two points in space. In Figure 3.4, it would be geometrically correct, for example, to define the distance between

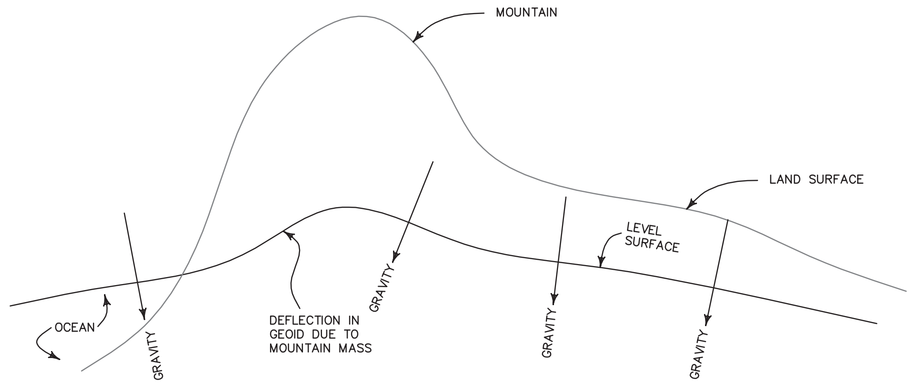

FIGURE 3.3

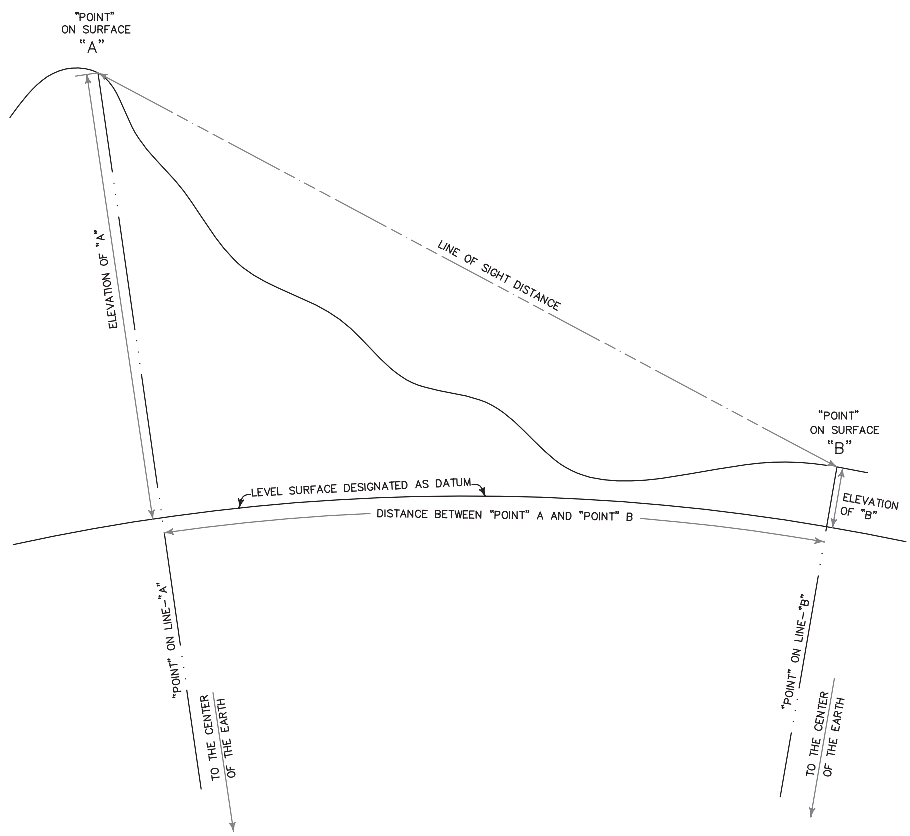

FIGURE 3.4

geometric point "A" on the surface of a mountain and geometric point "B" at the foot of that mountain as the measure of geometric line segment having "A" and "B" as end points. This is not the real property definition of the distance between these land points, because real property land points are actually rays.

Although the separation of two rays can be measured by the angle between them, and some private and many national boundaries are measured in this way, in real property terms, the distance between "A" and "B" is defined as being measured along a level surface from the intersection of one ray to the intersection of the other. Land distances are often referred to as the "horizontal" distance.

Notice that, under the real property definition of *distance,* changes in the topography do not alter the land distances. The mountain could be scraped away, but the land distance between point "A" and point "B" would remain the same. It is because of the need to reduce field measurements, which are geometric distances, to land distances, as well as the need to apply a multitude of other correction factors, that, except for very short distances, it is rare for the values shown on any survey plat to be the result of a single, direct measurement.

Distances are dependent on a standardized length. There is no naturally occurring object that is consistently and universally the same length always and everywhere, so a standard had to be created. The meter is the international standard unit of distance measurement. Although it is slowly, very slowly, being replaced by the meter, the U.S. survey foot is the most common unit of measure for real property boundaries in the United States. The U.S. survey foot is slightly longer than the U.S. standard foot, the difference being only about three-thousandths of a foot in one mile. This difference is significant only in long-range, very high-precision work. Other units of measure and the conversion factors for each are shown in Table A.1 in the appendix of tables.

3.8. ELEVATION

Distances can also be used to describe or measure the separation of two level surfaces. This sort of measure is usually identified as "elevation." The most common use of elevation is in describing all surfaces from a common base or vertical datum. In Figure 3.4, the level surface shown might represent such a datum. The distance from the datum to the level surface containing point "B," measured along a plumb line, would be the elevation of "B" as referenced to that datum.

Many different areas have established, through convention or municipal and state government, local vertical datums. These different datums are being rapidly replaced by the federal standard datum established by the National Geodetic Survey (NGS). This federal datum is known as the North American Vertical Datum of 1988 (NAVD 88). This replaced the NGS-defined National Geodetic Vertical Datum of 1929 (NGVD 29). Both datums are frequently and incorrectly called mean sea level (MSL). Neither is a sea level datum. Local mean sea level will vary greatly from the national datum.

The NGS has consistently emphasized that NAVD and NGVD are not sea level datums. NGS has also emphasized that NGVD is no longer supported and should not be used for surveying or engineering projects. In spite of this, many agencies, even federal regulations, will occasionally refer to NGVD or “mean sea level” or “MSL.” Local sea level must be determined by observations of the tide. Such observations can render a sea level value in terms of NAVD.

Elevations are every bit as important in real property measurements as are horizontal distances and angles. More personal disasters have occurred because an individual’s real property was below a certain elevation (a high-water mark, for example) than because of shortages in horizontal measure or improper horizontal location. In many regions of the country, there are significant changes in elevations taking place because of subsidence or heaving of the surface. Some changes in reported elevations are superficial—the result of improved measurement procedure. Many more of the changes are the result of actual surface movement. It is important, in regions of rapid changes, that elevation information be current.

3.9. LAND AREA

In the same way that real property distances are horizontal measurements usually defined at some datum, land areas are also defined as “horizontal” or “level” and are usually referenced to the same datum as the horizontal distances. The actual surface of a tract of ground—that is, the air-land interface, can be altered by earthwork. Leveling hills or plowing furrows alters the exposed surface of dirt, but land areas, as defined in real property terms, cannot be altered by earthwork.

3.10. HORIZONTAL ANGLES

Because real property lines are actually vertical planes, the intersection of these planes will form a vertical ray or a land point. A plane perpendicular to this vertical ray will also intersect with these

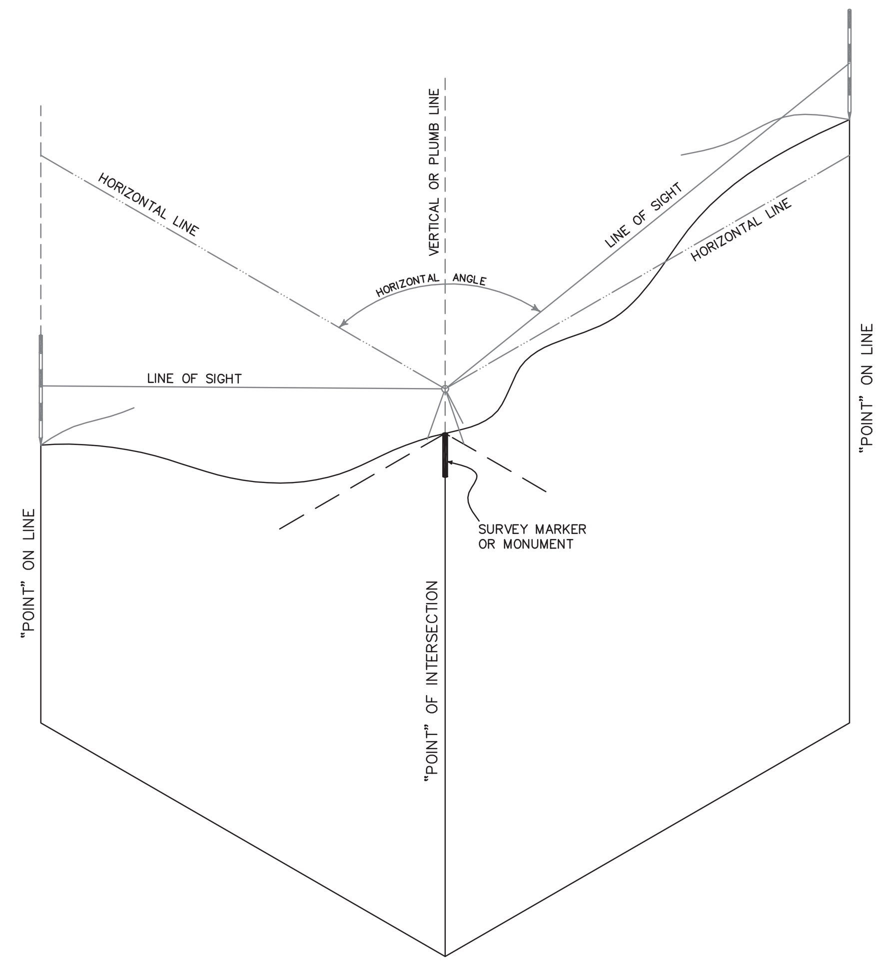

FIGURE 3.5

vertical places, forming two "horizontal" geometric lines. It is the angle between these two "horizontal" lines that is reported as the angle of a property boundary intersection.

Many have found it convenient to refer to the angle between two such lines as if the measurement were an action that took place by turning from one line to another. When this sort of "reckoning" is used, angles are said to be positive, or to the right, if the direction of the imaginary "turn" is clockwise when observed from above, and negative, or to the left, if counterclockwise.[1] Consequently, the angle in Figure 3.5 could

[1]The actual process of measuring angles is not at all dependent on the "direction" of the reckoning.

be said to be 90 degrees, or to the right, from “A” to “B,” but –90 degrees, or to the left, from “B” to “A.”

3.11. VERTICAL ANGLES

Vertical angles are measurements between geometric lines in a vertical plane. Because real property boundaries are vertical planes, vertical angles rarely find their way into property descriptions. Vertical angles are commonly measured in order to compute horizontal and vertical distances. Figure 3.6 illustrates a vertical angle.

3.12. DEGREES, MINUTES, AND SECONDS

All angles are based on a definition of a unit, not a standard. A point traversing a circle will, when observed from the center, appear to travel the same distance to complete one circuit, no matter where that circle or observer is in the universe. One could contact an alien on another planet and describe a “degree” as $^{1}/_{360}$ of a circle, and that alien could duplicate the standard, having never seen an example. However, no amount of verbal description would allow the alien to duplicate the U.S. survey foot; the alien would have to be given a physical example in order to duplicate it.

The relationship of the circumference with the radius of a circle is a natural constant. All angular measurement is defined in terms of a full circle. Table A.2 in the appendix of tables lists the most common definitions for angular measurements. In the United States, the most common definition of angular measurement is 360 degrees to a circle. The degree (noted by the symbol $^{\circ}$), is divided into minutes (noted by the symbol $'$), which is $^{1}/_{60}$ of a degree. The minute is divided into seconds (noted by the symbol $''$), which is $^{1}/_{60}$ of a minute.

3.13. MAPS OR PLATS

A map or plat is a report of a survey in the form of a drawing. The root cause of the confusion between the terms used in real property descriptions and between identical terms, with very different geometric meanings, is the widespread use of maps or plats.

Since the invention of paper, and perhaps even before that ancient time, people have communicated to one another the location of places on the surface of the earth by drawing lines on a flat surface. First as

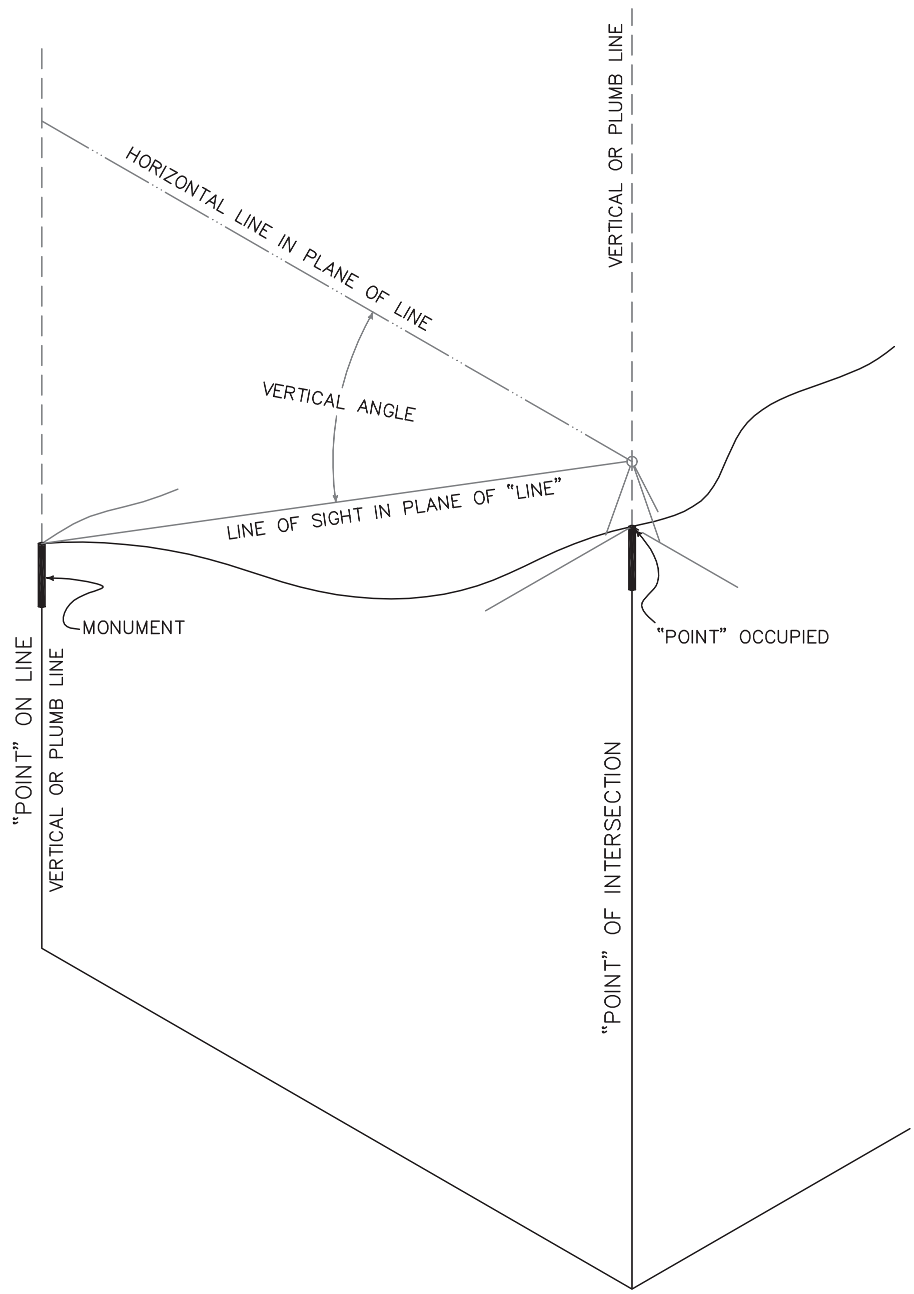
VERTICAL OR PLUMB LINE
HORIZONTAL LINE IN PLANE OF LINE
VERTICAL ANGLE
LINE OF SIGHT IN PLANE OF "LINE"
MONUMENT
"POINT" OCCUPIED
"POINT" ON LINE
VERTICAL OR PLUMB LINE
"POINT" OF INTERSECTION

FIGURE 3.6

lines scratched in the dirt and then as ink lines on paper, the map was developed as a communication aid. Even after the concept emerged of drawing line lengths and angles to scale, the map or plat was, is now, and always will be a two-dimensional representation of a three-dimensional reality.

A map is not a model. The interaction of ink lines drawn on a map is not the same as the interaction of real property land lines on the earth. Yet we persist in using the words and descriptions of the two-dimensional map as if it, and not the earth's surface, were the thing being described.

CHAPTER 4

DEFINING NORTH

Descriptions of real property boundaries often use terms that report the orientation of each of the boundary lines with a common line or datum. This orientation is called the "direction" of a boundary. The most common datum for boundary directions is "north." Once again, the commingling of three-dimensional terms, two-dimensional instincts, and one-dimensional verbiage makes it necessary to separate and explain each concept in terms of what is really happening, what is shown, and what is described.

No concept in real property boundaries is so widely misunderstood as the term *north*. The misuse of this term in real property boundary definitions is so pervasive and so perfectly demonstrates the distortion of three-dimensional reality that a complete understanding of this single term and its many variations is required.

4.1. TRUE NORTH

True north is a three-dimensional term. In real property terms, straight land lines are defined as "true north" if the axis of rotation of the earth is entirely contained in the plane of that straight line. There are an infinite number of "true north" lines. All "true north" lines are straight land lines, but *none are parallel*.

4.2. ASTRONOMIC NORTH

Astronomic north was long believed to be true north. The apparent rotation of the stars, first observed by the ancients, is still used today as an accurate and universal method of determining the rotational axis of the earth. Unfortunately, the measurements of the angles between the horizon and the axis of rotation of the earth depend on an accurate determination of "down."

We must usually make the observations of the apparent movement of the stars at a point on the surface of the earth. This close proximity with the surface of the earth means that the pull of gravity, the "plumb line," will not always point toward the center of the earth. Land mass anomalies frequently deflect the plumb line from the vertical. Because these deflections distort celestial observations, astronomic north lines are not quite straight land lines but are meandering land lines that closely approximate true north. Astronomic north lines can be adjusted to "true north" by the application of regionally varying correction factors. These corrections are typically, but not always, very small.

4.3. MAGNETIC NORTH

Magnetic north is not directly connected to the rotational axis of the earth. The earth has a naturally occurring magnetic field focused on points near the Arctic and Antarctic regions. These points of focus, or poles, are not stationary, and the magnetic lines associated with these poles are far from straight and are not true land lines, for their location and intensities vary with altitude. These "lines of magnetic force" are easily interfered with or deformed by surrounding conditions. Alignment with these magnetic lines defines "magnetic north."

The corrections required to translate magnetic north, as observed at a point on the surface of the earth, to true north vary so rapidly that it is quite useless to attempt even a moderately accurate determination of true north based on magnetic observations. In spite of this, many old survey procedures were regularly based on magnetic lines and required the surveyor to adjust the directions observed on a compass by what was believed to be the variation of magnetic north from astronomic north, called "declination," or sometimes "deviation." The results of such practices will be discussed later.

4.4. ASSUMED NORTH

When the direction depicted as north is based on something other than observations intended to detect the axis of rotation of the earth, that direction is referred to as *assumed north*. Many, if not most, boundary surveys use an assumed north as the direction of orientation. Many survey plats fail to state the type of "north" used to define the directions on the plat. In such cases, it is almost certain that the north used was an assumed north.

It is also quite common for a survey plat, especially an old one, to report the base direction as "true north" when, in fact, the direction of orientation is an assumed north. *Assumed north lines are unique to each particular survey and have no fixed relationship to any other assumed north*. Chapter 12, which deals with the evaluation of survey plats, will demonstrate how to identify the type of "north" used in a survey plat.

4.5. GRID NORTH

Of all the "north" terms discussed in this chapter, *grid north* is the only two-dimensional term. If a flat plane is divided into a set of evenly spaced parallel straight lines intersecting at right angles (90 degrees) with another set of evenly spaced parallel straight lines, the resulting pattern is a "grid." "Grid north" could then be defined as a direction parallel with one of these sets.

This grid pattern (Figure 4.1) could be defined as having a specific relationship to portions of the surface of the earth. When this occurs, such a grid pattern can become an effective tool in mapping the earth's surface.

All maps, which are two-dimensional planes, depend in some way on a grid pattern to control locations of the drawings and symbols that represent land features. The science of cartography is the highly complex and technical study of the methods and concepts necessary to present the surface of the earth as a two-dimensional grid (map). (Later in this book, we will examine briefly some of these methods.) Unlike true north, astronomic north, and magnetic north, grid north lines are parallel.

4.6. DIRECTIONS

The various concepts of "north" discussed so far have dealt with land lines or planes that are oriented along the earth's axis of rotation. There

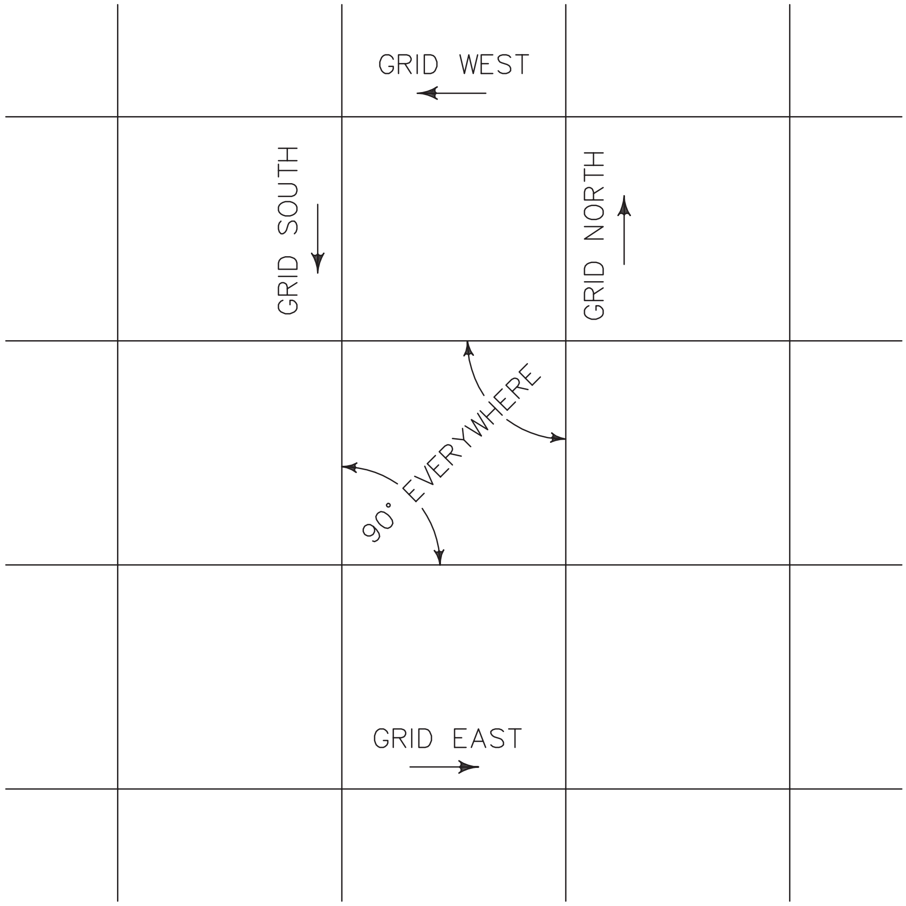

FIGURE 4.1

is an infinite group of land lines or planes that are not "north lines." These land lines can be, nevertheless, defined by their relationship to a particular "north." Azimuths and bearings are two universally accepted methods used to describe that relationship. Both of these methods are systematic reports of the angles formed between a land line and a meridian. The particular meridian used *must be defined*.

In the examples for azimuths as well as for bearings, the values report the relationship of land lines (flat planes) that intersect at a land point (vertical ray). The various definitions of direction are the same for each of the types of "north" involved. The methods of identifying directions and the verbiage employed are the same in two-dimensional systems.

Imagine a flat plane perpendicular to the line of intersection of a land line and a meridian. The vertical ray that is the line of intersection will appear as a geometric point on that imaginary plane. The vertical planes that are the land lines and the meridian will intersect the imaginary plane as geometric lines. The description of the relationship of the land line and the meridian has now been reduced to a two-dimensional image. This relationship is valid only *at a particular land point of intersection*. Reducing an intersection to a two-dimensional relationship for the purposes of describing the direction of a land line *does not eliminate the three-dimensional nature of the land lines involved*.

In Figure 4.2, the line A–C intersects the north or meridian line at point B. Because the meridian is a straight line at point B and line A–C is a straight line at point B, then only one of the angles created needs to be reported or measured to define the direction or orientation of line A–C. Because azimuths and bearings developed as an aid to navigation or travel, both have the ability to distinguish the direction "B" to "A" from "B" to "C." This one-dimensional aspect often causes confusion among users of land information.

4.7. AZIMUTHS

Azimuths are "measured" or "reckoned" from the north in most cases.[1] Some organizations "reckon" azimuths from the south. Azimuths are always said to be clockwise, meaning that the observer would "turn right" from the meridian to the line being reported. If an observer standing at "B" in Figure 4.2 were to face north, a right turn of 30 degrees would cause the observer to face "C." A right turn of 210 degrees (30 degrees + 180 degrees) from north would cause the observer to face "A." Therefore, line "A–C" could be reported as having an azimuth of 30 degrees or 210 degrees. *Both azimuths describe the same line*. Azimuths are always less than 360 degrees.

4.8. BEARINGS

Bearings are "reckoned" clockwise or counterclockwise[2] from the meridian and are always less than or equal to 90 degrees. In the case

[1] In actual practice, the measurement of angles involves a process that is independent of such "reckoning."

[2] "Clockwise" is defined as a turn to the right from the meridian, and "counterclockwise" is defined as a turn to the left.

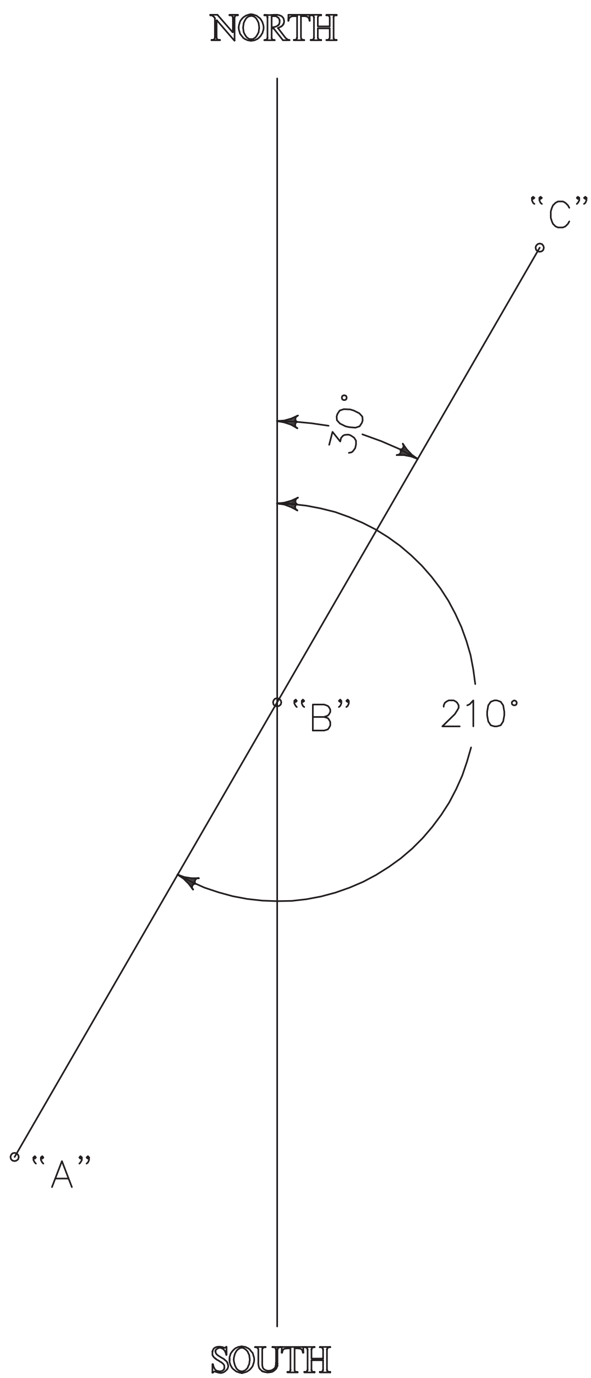

FIGURE 4.2

of bearings, the reporter defines lines as being east or west of north, or east or west of south. This method is easily comprehended and widely favored by most users of real property information.

In Figure 4.3, land line "D–F" has been added to the Figure 4.2. If an observer at "B" were to face north, a right turn (clockwise or to the east) of 30 degrees would cause the observer to face "C." The bearing to "C" is north 30 degrees east. If that same observer at "B" were facing south, a right turn (clockwise or to the west) of 30 degrees would cause the observer to face "A." The bearing to "A," therefore, is south 30 degrees west. The bearing of land line "A–C" could be reported as being north 30 degrees east or as being south 30 degrees west. *Both bearings define the same land line*. The distinction of when to use one rather than the other will be discussed in Chapter 13.

If the observer were to face north and turn left (counterclockwise or to the west) 10 degrees 15 minutes 22 seconds, then the observer would be facing "D." The bearing to "D" is north 10 degrees 15 minutes 22 seconds west (written N $10^\circ\ 15'\ 22''$ W). If the observer were to face south and turn left (counterclockwise or to the east) 10 degrees 15 minutes 22 seconds, then the observer would be facing "F." The bearing to point "F" is S $10^\circ\ 15'\ 22''$ E. Both bearings describe land line "D–F."

If the magnitudes of the angles are the same, north–east bearings and south–west bearings describe the same line and are clockwise, or reckoned to the right. If the magnitudes of the angles are the same, north–west bearings and south–east bearings describe the same line and are counterclockwise, or reckoned to the left.

The concepts for bearings and azimuths discussed and sketched earlier are based on a relationship of lines *at a particular point*. In two-dimensional geometry, the meridian and all north–south grid lines are parallel, but, in the three-dimensional world of real property boundaries, meridian lines, such as longitudes, are not parallel with any other north–south line. Because straight real property lines are actually flat planes through the center of the earth, the following facts are true, although they may come as a shock to the "flat-earth" believers among us:

1. There cannot be two parallel straight lines.

   Because every straight land line is actually a plane containing the center of the earth, then every such plane must intersect. For any two straight lines, there are two places on the surface of the earth where these lines intersect; therefore, no two straight land lines can ever be parallel!

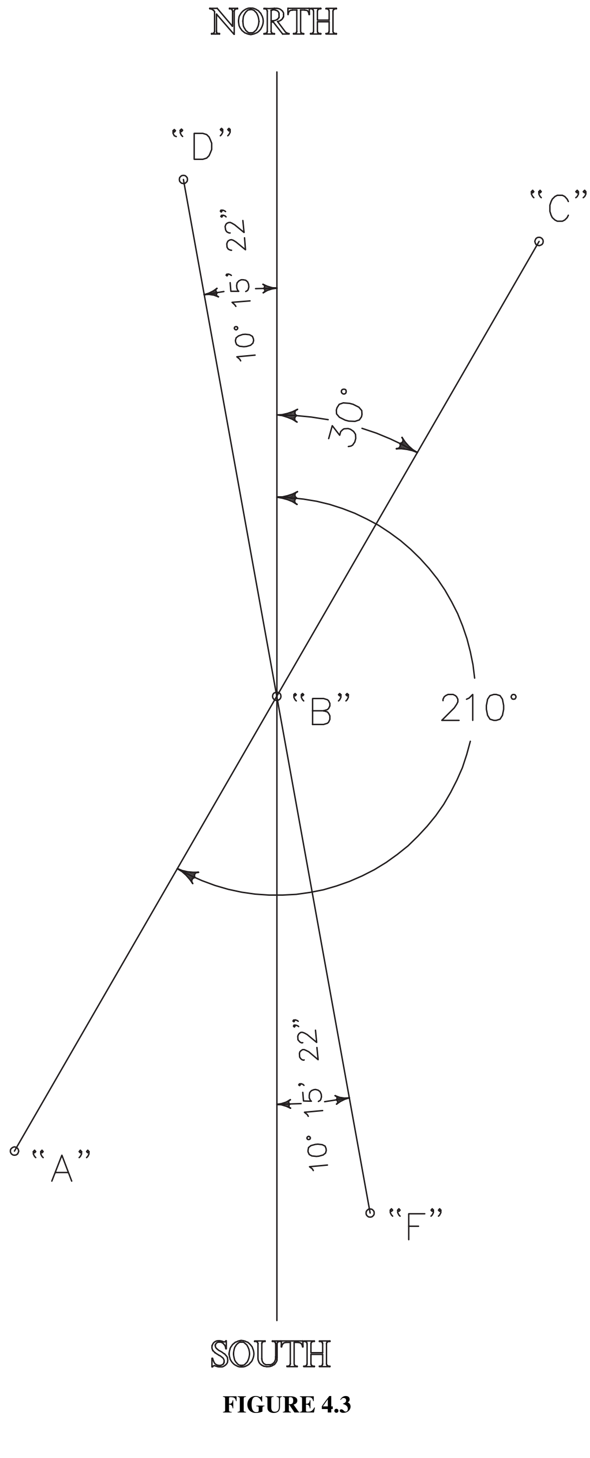

FIGURE 4.3

2. The bearing of straight lines (except for north–south lines and the equator) vary throughout the line.

   Because none of the north–south lines are parallel, then a straight line that crosses several north–south lines must do so at a different angle for each north–south line.

A simple examination of a globe is all that is needed to confirm that north–south lines (lines of longitude) are not parallel (they meet at the poles). East–west lines (lines of latitude), however, are parallel but, except for the equator, none are straight land lines.

The consequences of these facts in documenting real property transfers are best demonstrated by an example. Let us return to the ranch in Montana. We might attempt to mark a square mile of land in many ways. First, if we were to mark every step of the woman walking in the scenario, we would notice several things. The north leg of the trip would be a straight land line segment, one mile long. The east leg of the trip would be a land line segment curving to the north, one mile long. The south leg of the trip would be a straight land line segment, one mile long. The west leg of the trip would be a land line segment

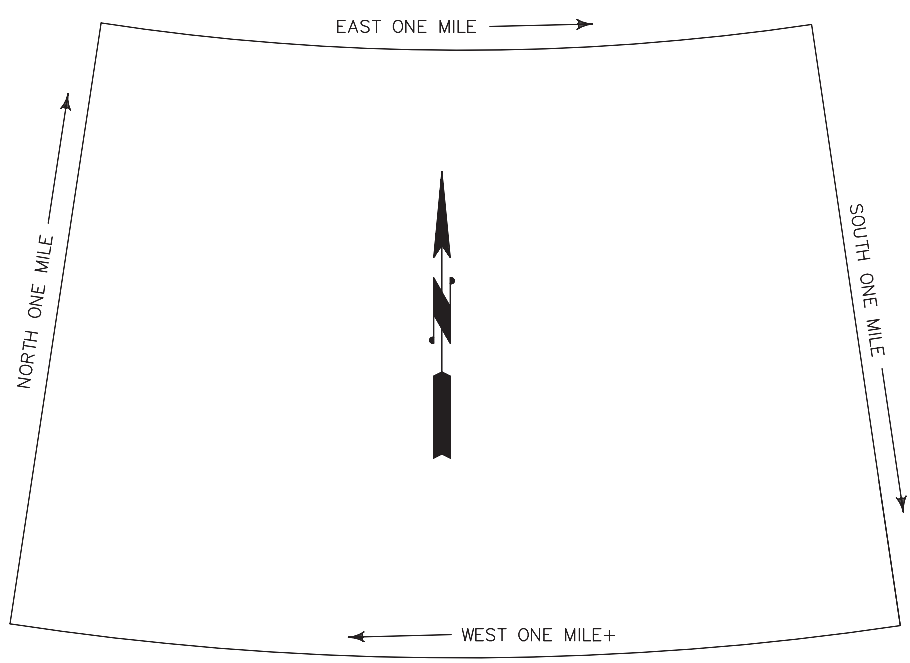

FIGURE 4.4

curving to the north, and, in order to return to the starting point, the walker would be required to travel slightly more than one mile.

In this example, such a closed circuit could represent a land parcel. This parcel could be described very accurately by reporting the directions and distances of the route. Figure 4.4 is an exaggerated drawing of such a parcel in Montana.

Although the parcel shown in Figure 4.4 is completely possible, the curved lines of the northern and southern boundaries are difficult to mark on the ground. By curving the lines on the figure, the actual shape of the parcel can be approximated. This is not possible with larger areas of land. The convenience of straight boundary lines,[3] as well as the human desire for regular shapes, reduces the acceptance of such a strict geodetic definition of real property parcels.

[3]The greatest convenience of straight land lines is that only the ends (corners) need to be marked to define clearly the location of that line on the ground.

CHAPTER 5

PROJECTION SYSTEMS

5.1. PROJECTIONLESS MAPS

The first attempts at drawing maps in a scaled and controlled manner where the distances, locations, and directions, as observed on the ground, were reproduced in miniature on a sheet of paper failed miserably. Model globes are excellent miniatures of the earth, but the scale required is far too small for practical application.

Except for very small land parcels, the first attempts at mapping land areas on flat sheets of paper (now called "projectionless mapping") resulted in inconsistencies of ever-increasing magnitude as the area being mapped was enlarged. This was because the earth's surface is not flat. However, to be able to talk about, draw, refer to, and think of real property parcels in two-dimensional terms by using maps, sketches, or plats is so necessary, basic, and instinctive that methods had to be developed that would be able to transfer the surface of the earth to a flat plane.

The systems that were developed are called "projection systems." There are many different versions of projection systems—too many to enumerate here—but the advantage of all projection systems is that, when applied, land surface areas can be mapped and described in two-dimensional terms. Straight lines can be parallel, and all straight lines will have constant bearings throughout. *Point, line, angle,* and other geometric terms can now be correctly used in their two-dimensional sense to designate real property features.

As long as the user is aware of the fact that a projection is involved, maps and property descriptions are readily developed and can, very accurately, reflect real property parcels. The few systems that are going to be discussed here are all "conformal" projection systems. This means that angles measured at the surface of the earth are presented on the projection (map) with minimum distortion.

5.2. TANGENT PLANE PROJECTIONS

The most common form of plane projection systems in use today is the tangent plane projection system. Although it is slowly being replaced by more sophisticated systems, most survey maps or plats are based on this simple system. This is especially true of small surveys and surveys performed before the World War II. Modern, large-tract surveys are less likely to be based on this system because of several disadvantages that affect accuracy and recoverability.

Figure 5.1 is a visualization of a tangent plane projection. Imagine that a flat plane of glass is balanced on a globe. The plane would touch the globe in only one spot. This is the "point of tangency." If one were

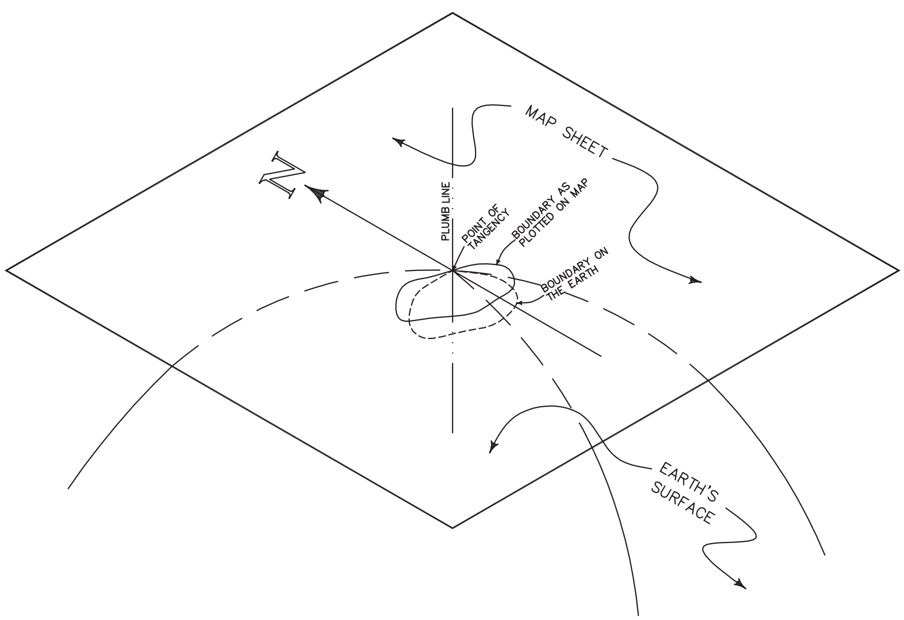

FIGURE 5.1 Tangent Plane Projection

to look down through the glass from directly above the globe, features on the globe would be visible. These features could then be traced on the glass in their apparent positions as observed from above.

The tracings on the glass would be a map of those portions of the globe visible from above. The features mapped would become increasingly distorted as the distance from the point of tangency increased. The area very near the point of tangency would have minimum distortion and, depending on size and precision requirements, could become a very serviceable two-dimensional map of that portion of the globe.

The procedures for establishing a tangent plane projection in order to survey and map a parcel of land roughly imitate the preceding example. There are many variations of this procedure—some of which will be discussed later—yet all tangent plane systems have certain common factors. Concepts or steps that are *italicized* in this discussion will be those things common to all forms of tangent plane systems.

In order to *establish the point of tangency*, the Land Surveyor may choose a location on or near the area to be mapped or surveyed. This location is the point where the Land Surveyor *orients the work to some form of directional control* that is recoverable, meaning physical marks on the ground, magnetic observations, celestial observations, or any procedure that defines a direction that can be repeated by another, at another time.

True north is widely claimed but almost never used as this control meridian. The most common form of directional control in boundary surveys of this type is an assumed north created by the recovery of a reported bearing. A "reported bearing" simply indicates that two or more marks set by a previous Land Surveyor were found and that the direction between these marks reported by the previous Land Surveyor was used as the directional control for the present work. Sometimes the control direction may be entirely "assumed"; that is, the Land Surveyor did not use a known or recoverable direction as a control.

The Land Surveyor then *measures the angles formed between lines of the survey and the control direction*. (This is very different from independently measuring a magnetic or astronomic direction for each line, as is the case in projectionless maps.) The angles so measured during the survey may then be drawn, two-dimensionally and to scale, on the map or plat. More commonly, the relationship of the land lines in the survey with the control direction are expressed by reporting the bearings of the lines on the map. When such bearings are used, they are *two-dimensional computations based upon angles measured from the control direction*. Bearings shown on tangent plane projections, and even those correctly based on true north, *do not represent the geodetic,* *astronomic, or true bearing of the land line*, except along the meridian that passes directly through the point of tangency. *The curvature of the earth and the convergence of the meridians are ignored*.

The distances measured during the survey are reduced to horizontal distances at a local datum. No adjustments are made to compensate for differences between distances between points on this level surface and distances between the same points on the flat plane of the projection. In short, the tangent plane projection system accounts for the curvature of the earth by ignoring it. Indeed, so little attention is given to the shape of the earth in performing tangent plane projection surveys that many people, even Land Surveyors, forget that every map or plat derived from measured angles and distances is the projection of a curved surface onto a flat plane.

5.3. ADVANTAGES OF TANGENT PLANE SYSTEMS

The advantages of a tangent plane system are many and compelling. Chief among these advantages is the ease with which such a system is established. The Land Surveyor has a wide choice of methods of directional control and complete freedom in choosing the point of tangency. This freedom reduces to a minimum the fieldwork required to map a particular parcel of land.

Knowledge of the elevation or geodetic position of the area being surveyed, in order to account for the earth's shape, is not necessary. Because the shape of the earth is ignored, there is no need to collect information on the geodetic positions of points within the parcel. This is a further reduction of the fieldwork required to survey and map a parcel of land.

The computations required are all two-dimensional and relatively simple. Field personnel do not need to master geometry beyond the high school level in order to understand and execute the data collection required. This reduces the formal training required of entry-level survey crew members, as well as the on-the-job training needed to attain adequacy. Because training requirements are low, salaries paid to field personnel are also typically low, especially when the responsibilities and the value of the work performed are considered. Consequently, the initial or "first-time" costs of tangent plane projection surveys are comparatively low.

Straight land lines have constant bearings. Parallel straight land lines exist and have the same bearing. Landowners and other laypersons quickly accept and understand the maps or plats produced by this system because the information conforms to their flat-earth instincts. The intricacies of defining land lines on the earth are greatly reduced and simplified.

Distances used in computations and shown on maps do not require a lot of "refining" and, in most cases, are simply a report of the level distance between land points at the average elevation of the site. Indeed, changes in elevation throughout the site are rarely great enough to be significant.

5.4. DISADVANTAGES OF TANGENT PLANE SYSTEMS

The disadvantages of tangent plane projection systems are as numerous, although not as obvious, as the advantages. Unless referenced to the same point of tangency, tangent plane surveys are like crackers floating in a bowl of soup: each is free of the other without any ties or a common reference base. This means that a survey based on the tangent plane projection will not contain any information about that particular survey's relationship to any other work that is not a part of the present survey.

Other surveys in the area, even those of adjacent properties, will disagree on the dimensions and directions of common lines. The directions between identical points on adjacent parcels will show different values. This lack of consistency of direction means that discrepancies, overlaps, disputes, or other irregularities will not be apparent by merely reviewing the survey maps of adjacent parcels. Potentially devastating conflicts in deeds may go unnoticed for generations until clear acts of possession take place.

Resurveys of real property parcels are entirely dependent on recovery of survey marks or monuments set during the original work. This greatly increases the time required to retrace previous work. Failure to recover at least part of the original work will result in a retracement that has a poor probability, at best, of remarking boundaries in their original locations. Because permanence of boundaries is an integral part of the rights of possession, this is a most serious flaw.

Tangent plane projection surveys are of little use to land planners, municipal utilities, and other governmental agencies, because the lack of a common reference base makes the task of relating several parcels to each other very difficult. Multipurpose land record systems, so vital to proper community planning and resource planning, can make little use of the work of private tangent plane surveys because of the lack of a common reference base.

Recovery of boundaries, resurveys, and resubdivision of existing parcels require extensive field recovery and frequent judgmental decisions by the Land Surveyor. This greatly increases the costs of resurvey or recovery work and increases the possibility of conflicts. In the long term, tangent plane projection surveys can be much more expensive than more sophisticated systems. This "hidden cost" limits the cost effectiveness of tangent plane projection surveys to very small, usually urban, parcels, where boundary lines are well established, clearly marked, and well maintained.

Because the area surveyed under a tangent plane system must be kept quite small, or the factors ignored by the system will result in unacceptable irregularities, this eliminates the tangent plane system for use in large-tract surveys, highway routing, and state- or county-level property accounting.

5.5. STATE PLANE PROJECTIONS

The rapid increases in land values, the need to mark real property boundaries permanently and precisely, the increasing governmental adaptation of Land Information System (LIS) and Geographical Information System (GIS) databases,[1] and many other factors have led to the wide use of projection systems that eliminate some of the disadvantages of the tangent plane system. This need was so prevalent that, late in the 19th century, the federal government of the United States began promoting the use of particular projection systems adapted to each state.

Known as State Plane Coordinates (SPC), the system is based on a rigorous mathematical translation of Geodetic Positions into a Grid Coordinate system. The adoption of SPC in private surveys gradually increased through the 20th century. Modern advances in Geodetic Positioning in the 21st century have made the control required for SPC-based surveys available to every Land Surveyor in every corner of the world. The specific version of SPC control that each state adapted is codified in that state's law. The projection systems used vary greatly, but the benefits, application, advantages, and use of these systems is the same for every state.

One form of state plane projection is demonstrated in Figure 5.2. Instead of a rigid plane of glass, as in Figure 5.1, imagine that a clear, flexible sheet of plastic is wrapped to form a cylinder around a globe.

[1] See Chapter 9.

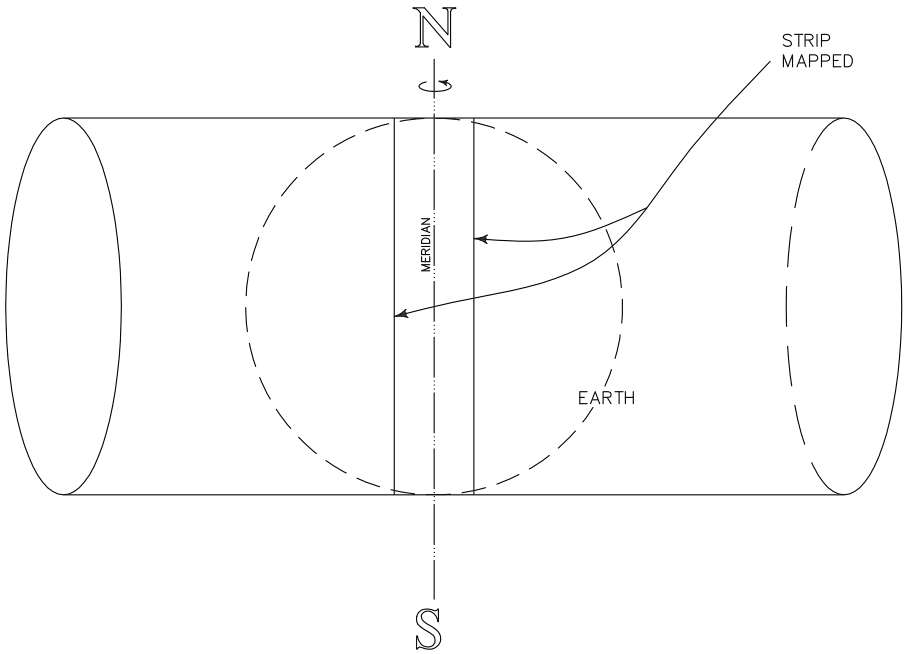

FIGURE 5.2 Transverse Mercator Projection

Then the sheet would touch the globe in a series of points instead of in one place. The features visible through the sheet could be traced onto the plastic, and, when unrolled, the sheet of plastic would form a flat plane on which a map of the globe would appear. The features on the map would become distorted as the distance to the line of contact was increased. The area near the line of contact would form a strip that would closely match the globe.

Let us further visualize that, instead of using a blank sheet of plastic, we begin with a clear sheet of plastic that has a rectangular grid pattern already established on it. This grid could consist of two sets of parallel lines intersecting at right angles, and each line would be defined by its distance from an established origin. The distance east is called the "x" distance. The distance north is called the "y" distance. When this grid sheet is wrapped around the globe, we could also deliberately align one of the grid lines with on of the north lines on the globe along the line of contact. Now, for each and every feature on the globe for which there exists a geodetic latitude and longitude measured in degrees, there can be found a corresponding grid location on the projection denned by the "x" distance and the "y" distance on the grid and measured in feet or meters, depending on the system.

Because the relationship of the sheet of plastic and the globe was rigorously controlled, then a specific set of such strips could be used to map the entire earth. In actual practice, this is what is done through mathematical manipulation of the geodetic positioning network. This procedure and innovative variations of it (using cones or other adaptations) have produced mapping systems that cover large portions of every state. Most states are typically served by two or three overlapping projection zones.

Maps and surveys developed in these systems are tied to the worldwide geodetic positioning system of latitudes and longitudes. The projection accounts for the convergence of the meridians, as well as the elevation of the parcel. The system mathematically and rigorously projects a portion of the earth's surface onto a theoretical flat plane. The portion of the earth mapped is typically a strip, about 150 miles or so wide, wrapped around the earth. Most states are divided into overlapping zones in order to obtain full coverage.

The geodetic monumentation network that supports these projections is maintained by the federal agency known as the National Geodetic Survey (NGS). This agency is responsible for the development and definition of the mathematical models used to approximate the earth. The foundation of this model has undergone significant renovation in recent years. The consequences and advantages of these modifications will be explored.

The development of the Global Positioning System (GPS)[2] using a constellation of satellites has greatly reduced the dependence on surface monumentation for precise positioning. Even greater advances, such as the continually operating receiver station (CORS) and the discoveries associated with that system, will be discussed at length later in this book.

All national mapping is also controlled by this geodetic network. The control network includes both horizontal control (geodetic positions) and vertical control (elevations). Any survey work that is performed as part of this network is automatically tied to any other work in the system, be it private or public surveys.

The procedure for establishing a state plane projection survey requires that the Land Surveyor recover one or more monuments of known geodetic position.[3] The latitude and longitude of the

[2]See Chapter 8.

[3]This process is being modernized greatly, as discussed in Chapter 8.

known location is "projected" to the flat state projection plane by a mathematical process. The location of that point on the projection plane is defined on the two-dimensional grid. The "x" value defines the distance east, whereas the "y" value defines the distance north. The process is reversible: If the "x" and "y" of a particular location are known on any state plane projection system, the corresponding geodetic latitude and longitude of that location can be computed.

The Land Surveyor then measures the angles formed between land lines and the distances between land points in much the same way as in the case of the tangent plane projection. The major exception is that the computations systematically account for the curvature of the earth by converting level distances to grid distances and by defining all directions in terms of grid bearings. The adjustments to bearings and distances are "hidden" and usually not presented on the finished plat. The final map or plat produced will show the level ground distances measured, not the grid distances used during computations.

5.6. ADVANTAGES OF STATE PLANE PROJECTIONS

The advantages of a state plane projection system are numerous, if not apparent. The primary advantage is that, because surveys performed under these systems become, in a sense, a part of the national geodetic network, the boundary corners defined in the survey can be related to all other surveys in the system. Boundaries, therefore, need not rely solely on the recovery of marks within the survey in order for the Land Surveyor to learn of that parcel's relationship to some other tract.

The recovery of boundary marks defined in state plane projections is greatly expedited by reducing considerably the area of search. This reduces the cost of resurveys, resubdivision, or recovery of existing parcels. Indeed, in areas where the use of state plane projection systems is widespread, even the cost of initial surveys is greatly reduced.

The information shown on adjacent tracts of land, and even remote tracts, can be related to the parcel surveyed. Surveys of adjacent properties will report (within the margin of error) the same bearings and distances for common lines. This makes the problem of discovering inconsistencies between adjacent tracts much simpler.

Municipal, county, and state-level projects and planning are more easily controlled and regulated. Highways, pipelines, utilities, and other public works are defined in relationship to every private parcel surveyed under the state plane system. This enhances the acquisition of rights-of-way by increasing the precision of the description of the areas acquired.

The Land Surveyor uses marks set by the NGS[4] or other agencies that are at published locations and known to all. Marks that define horizontal location are called "stations." Marks that define vertical locations (elevations) are called "benchmarks." Both stations and benchmarks are part of an international network of control points and define locations based on a particular datum.

In areas where the national control network is not well monumented,[5] the state plane projection system can still be effectively used by a simple modification. If knowledge of the exact latitude and longitude of a point is not available (usually because of lack of monumentation), the approximate latitude and longitude, perhaps scaled from a U.S. quadrangle map[6] or provided by a simple navigational GPS receiver, are all that is required to convert astronomic directions in a particular area to precise grid directions. All the adjustments of the state plane system can be applied, and only the exact "x" and "y" of the survey points are excluded from the computations.

5.7. DISADVANTAGES OF THE STATE PLANE PROJECTION

The lack of control stations or monuments of known "x" and "y" in the immediate area of the survey may require extensive work beyond the area of the survey simply to make the "tie to the network" necessary for complete implementation. This disadvantage is being quickly eliminated by the introduction of artificial satellites in position determination. The geodetic position of locations on the earth can now be determined very precisely by using relatively inexpensive radio receiving stations in remote areas. The perfection of this method of determining location will mean that the type of control required by state plane projection systems will be available everywhere.

The computations and adjustments required in state plane projection systems are slightly more complicated than those required in the tangent plane system. The curvature of the earth and the convergence of the meridians are accounted for instead of ignored.

The educational and training requirements of field personnel performing state plane projection surveys are more extensive. The field crews must possess or acquire knowledge of both the real property

[4]For more information concerning the NGS control system, see www.ngs.noaa.gov.

[5]The latitude and longitude values obtained by navigational GPS units are accurate to within 30 meters or so and are not sufficiently precise for land surveys.

[6]For more information concerning USGS maps, see www.usgs.gov.

boundaries in the area of the survey and the geodetic positions of certain control points.

The additional training requirements and the additional fieldwork required sometimes result in the “first-time” survey costs of state plane projection surveys being more than those of tangent plane projection surveys of the same parcel. This is not true in cases where SPC-based surveys have been performed on adjacent tracts.

The few disadvantages cited indicate that, except for small urban parcels, the increase in costs for “first-time” boundary surveys are more than offset by the permanence, recoverability, and certainty of location that are rendered to real property boundaries documented by the state plane projection system.

CHAPTER 6

FUNDAMENTALS OF MEASUREMENTS

In the preceding chapters, we have made frequent reference to the *measurement* of angles and distances. It is very important to explain more fully the term *measurement*. Theoretically, there is only one true distance between two land points at a particular level surface. Likewise, there is only one acute angle formed between two rays or lines. The act of determining the values associated with these angles and distances is the act of measurement. Unfortunately, even the finest of measurements is only an estimate. Indeed, *all measurements are estimates!*

Measuring is not the same as counting. Counting is dependent on an indivisible fundamental unit, below which the thing or things being counted do not exist. The smallest unit of money is the penny. Even though we say that a dollar forms the basis of our monetary system, the penny is the smallest unit possible. Accountants do not measure the money in a bank; they count it. Empty your pockets and you either have 50 cents or you don't. Changes in quantity can only take place one penny at a time.

A great deal of time and effort has been and will continue to be expended by Land Surveyors in the pursuit of perfection in the *science* of geodetic measurements. Real property boundaries exist independently of measurements.

Boundaries are defined by the location of the real property corners.

Measurements of angles and distances are important because that is how we quantify, document, and describe boundaries. We will explore the procedures and histories of boundary-related geodetic measurements, but it is important to keep in mind that, while precise measurements are a very important part of boundary documentation, measurements *do not* define boundaries.

6.1. ACCURACY AND PRECISION

The terms *accuracy* and *precision,* when referring to measured dimensions, are not synonymous. "Accuracy" is an evaluation of the difference between a measured value and the "true" value. "Precision" is an evaluation of the procedure used to arrive at a particular value.

For example, assume that the distance between two particular points is exactly 500 feet. Two men are requested to determine the distance by whatever method they see fit. Mr. Jones stands over one point and, peering at the other, announces, "500 feet." Mr. Smith acquires a 100-foot measuring tape and carefully measures the distance several times and declares it to be 500.02 feet. Purely by luck, Mr. Jones's estimate was more accurate. Mr. Smith's estimate, because of procedure, was more precise.

6.2. IMPLIED PRECISION

Measurement data are usually presented by parameter (feet, miles, degrees, etc.) and numerical values. The form that the data are presented in contains a clue to the precision of the measurement procedure used to arrive at the value. This is only a clue, for unsophisticated reporters of measurement information can unwittingly change the implied precision of a reported measurement.

The nature of the parameter is important when implied precision is analyzed. A distance given in paces implies a precision far below that of a distance given in inches. A direction given in "points" of the compass (i.e., northeast) implies a precision below that of a direction given in degrees.

The division of the parameter is also significant, for it contains information about the smallest unit of measure used. A dimension reported as 22 feet implies that a foot was the smallest unit of measure. A dimension reported as 22 feet, 0 inches implies that an inch was the smallest unit of measure. The last figure given is said to be the "doubtful" figure in a measurement process. If a measurement were reported only to the nearest foot, then distances from just over 21 feet, 6 inches to just under 22 feet, 6 inches would all be reported as 22 feet. If measurements were reported to the nearest inch, then distances from just over 21 feet, $11^1/_2$ inches to just under 22 feet, $0^1/_2$ inches would be reported as 22 feet, 0 inches. The implied precision concept classifies 22 feet and 22 feet, 0 inches as two different measurements!

Fractions form another category under the implied precision rules. "$^1/_2$ foot" is not the same as "6 inches," nor is either one the same as "0.50 feet." The implied precision of $^1/_2$ foot is that the smallest unit of measure was $^1/_2$ of a foot. The implied precision of 6 inches is that the smallest unit of measure was an inch. The implied precision of 0.50 feet is that the smallest unit of measure was one-hundredth of a foot. One-fourth of a degree is not the same as 15 minutes, and 1 acre is not the same as 43,560 square feet when we are considering implied precision! Many a realtor has multiplied an area given in acres by 43,560 (square feet in an acre) to arrive at a square footage in order to determine a sale value. If an area is given in even acres, the square footage, under the implied precision rule, could be off by 21,780 square feet either way![1]

6.3. ERRORS

Measuring is typically dependent on the comparison of the thing being measured to a standard or known value. Variations in the accuracy of the standard value, the precision of the limits, as well as a host of other factors, introduce variables into the measurement process. These variables are called "errors." The word *error* has a very different meaning to the Land Surveyor or scientist than it does to the layperson. Measurement errors are a function of the level of refinement of the instruments, procedure and personnel conducting the work. Training, attention to detail, quality instrumentation, and a well-analyzed course of action will reduce the magnitude of not only individual measurements, but of the sum of the errors present in every survey.

There are three general categories of errors: systematic, random, and blunders.

[1]For a more detailed analysis on the theory of measurement, the reader is referred to R. B. Buckner, *Surveying Measurements and Their Analysis* (Rancho Cordova, CA: Landmark Enterprises, 1983); and E. M. Mikhail and G. Gracie, *Analysis and Adjustment of Survey Measurements* (New York: Van Nostrand Reinhold, 1981).

6.3.1. Systematic Errors

Systematic errors are inaccuracies in measurement that occur in the same direction every time that a measurement takes place. If, for example, a ruler were a fraction of an inch shorter than the length shown on it, then every measurement using that ruler would be off by the same amount and would mislead the user in the same direction. Objects would consistently be reported as longer than they really were.

6.3.2. Random Errors

Random errors are inaccuracies in measurement that occur in varying directions and magnitudes. Every time a carpenter measures a cut line, he or she must estimate the alignment of the end of the ruler with the end of the wood and the alignment of the marking pencil with the desired measurement. Each time these estimates are made, the carpenter might be off to the right one time and off to the left another. Random errors tend to be compensating; that is, they tend to cancel one another out when measurements are repeated several times.

6.3.3. Blunders

Blunders are not really errors in the strict scientific interpretation of the word. A blunder is the gross misinterpretation of a measurement due to a careless or mistaken observation. The carpenter meant to cut a 4-foot plank but marked the cut line at 3 feet. Blunders are mistakes. One thing was intended, but another was done. “Measure twice, cut once” is the old saying that addresses a type of blunder.

Blunders occur randomly, are usually large, and are rarely compensating. Blunders are what typically cause conflicts, confusion, and economic loss in the survey profession. Blunders are readily eliminated by the adoption of rigorous measurement procedures.

6.4. ALL MEASUREMENTS INCLUDE ERRORS

All measurements include errors. Imagine the following experiment. A classroom of high school students was instructed to attempt to measure the teacher’s desk using a feed store yardstick. The teacher requested that each student measure each dimension to the smallest fraction of an inch that he or she could estimate. As one would reasonably expect, some variations in the reported dimensions of the desk were reported.

The values for the width, for example, might have ranged from $40^1/_{32}$ to $40^7/_{32}$ inches. The average width reported would then have been $40^1/_8$ inches. One might report that the width of the desk was $40^1/_8$ inches, with a measurement error (uncertainty) of plus or minus $^3/_{32}$ of an inch.

The true width of the desk is not known and never will be known. The absolute, exact distance from the first molecule of desk on one end to the last molecule of desk at the other end is much finer than $^1/_{32}$ of an inch. The feed store yardstick is not a calibrated standard, and changes in humidity and temperature affect the length of the yardstick and the width of the desk. The variety of skill possessed by the many different measurers also influenced the results. The difference between the absolute width of the desk and the reported average width is the measurement error.

The students were engaged in a direct measurement. The standard (the yardstick) was applied directly to the desk. The beginning and end points were the limits of the value sought. This is the simplest act of measuring a quantity. If the students wished to reach a more refined value, they might have recorded humidity, pressure, temperature, and other factors and examined how variations in these factors affected the length of the yardstick. The students might have compared the length of the yardstick with a calibrated standard so that corrections for imperfections in the yardstick could be accounted for.

The problem of estimating the fractions of an inch might have been simplified by the addition of a vernier[2] or some other device that reduces the amount of interpretation involved. These are things that increase the precision of the measurement of the desk, but the fact remains that the measurement will never be absolute.

No matter how refined the process is there will remain a range of values that can result from correct and legitimate application of any measurement procedure.

6.5. REDUCTION OF ERRORS

The science of measurement is the study of methods or procedures that eliminate blunders, account for systematic errors, and reduce the effect of random errors.

[2] An auxiliary scale, mounted on the primary scale or ruler, that permits a direct reading of fractions (usually tenths) between divisions marked on the primary scale.

Some of the methods by which blunders can be eliminated are by repeating measurements, by careful observation, or by analysis of the results.

Some of the ways in which systematic errors can be accounted for include standardization of the equipment used, understanding the effects of the environment, and analysis of the results. Systematic errors must be detectable before methods to account for them are possible.

Some of the ways by which the effects of random errors are reduced include refinement of instrumentation (less estimation in interpreting readings), multiple observations, and analysis of results. How this is done in the modern land survey will be discussed later.

6.6. DEVELOPMENT OF STANDARD PROCEDURES

The history of land measurements is as ancient as the human race. The developments of methods of identifying locations discussed earlier were accompanied by attempts to perfect the measurement of angles and distances. Ancient societies that developed a centralized government soon employed people whose task it was to measure the area under the control of the central government. The earliest reports of these specialists come from Babylon, where pacing was extensively used to measure long distances. These professional pacers would report the distances between towns so that the king might know how many days it would take for his army to travel from place to place.

The Egyptians, long noted as master builders, used ropes of known length that were knotted at regular intervals in order to measure the fields and to lay out the great construction projects for which they are so well known. Many of the words we use today originate from the methods used to measure the land. The word *mile* is derived from the Latin *milia,* meaning "a thousand." The Roman soldiers would count each time the right foot struck the ground while marching. Each thousand paces was a milia. The average man today will cover about 5 feet for each pace (two steps), or 5,000 feet for a "milia."

Whether counting paces, turns of a wheel, camel paces, or any of a number of innovative means of measuring distances, the problem of a lack of a standard and inconsistency of results was a constant problem. The development of the Gunter's chain, by Edmund Gunter circa 1620, was the first real advancement in the measurement of horizontal land distances. The concept of standard length, horizontal measure, correction for temperature, and sag quickly followed this development. The Gunter's chain remained state of the art for measuring horizontal distances in land boundary surveys until the twentieth century.

The modern surveyor's steel measuring tape, still called a "chain," improved only slightly the measuring process and accuracy. It was not until the 1970s that the advent of the electronic distance measuring instrument significantly improved the accuracy of distance measurement. Global Positioning System (GPS) equipment (detailed in Chapter 8) is just another means by which distances and directions are measured. GPS-derived distances and directions have one great advantage. The locations that are being measured do not need to be intervisible.

Even with these new and fantastically accurate devices, there still exists a measurement error that cannot be eliminated. It is for this reason that many states have developed a set of standard survey criteria listing the size of error acceptable for various grades of survey work. Table A.3 in the appendix of tables is an example of a typical set of measurement standards. As the science of measuring the earth advances, the standards by which the Land Surveyor must abide become increasingly stringent. However, there will always be a "margin of error" in every boundary survey.

Unlike distances, the measurement of angles developed to a high precision very early in history. The capability of the modern Land Surveyor to measure angles has improved only slightly during the latter part of this century. Although the Land Surveyor of years ago probably did not avail himself of the most sophisticated angular measurement devices possible, the capability was there. Indeed, land surveying angles were rarely measured to any great precision until the art of measuring distances improved to the point where real precision was possible.

Yet, even when calibrated metal tapes are applied directly between boundary markers and all of the appropriate corrections are made, there is a range of values that will be observed. The conditions that affect this range are sometimes beyond the control of the observer. Size, shape, and the nature and condition of the end points of the land line segment being measured are significant factors.

If the northeast corner of farmer Jones's property is marked by a six-inch square concrete post, four feet of which is above the ground and leaning southwest several inches, while the northwest corner is marked by a four-inch diameter post, also several inches out of plumb, then even the most carefully applied measurement procedures are not going to be more precise than plus or minus a few inches. Before beginning the measurement, the Land Surveyor has to estimate the upright location of each corner and the center point of that upright location. The condition of the corner monuments are not such that a more precise measurement can be made.

The measurement of distance is not the only kind of measurement required in real property surveys. The angle formed at the corners of property parcels are also measured. The condition of the end points, uncertainty of location, and limitations of the instruments involved mean that the angles measured, like the distances, have inherent measurement errors that must be understood and accounted for.

Boundary lines are, more often than not, subject to acts of possession or acquiescence. Fences, hedges, tree lines, or other physical obstructions frequently occupy the full length of a real property boundary. These features, while clearly indicating the general location of the boundary, make the direct measurement of the distance between corners quite difficult. The vast majority of boundary dimensions in the world are the result of indirect measurement. Dimensions are almost always the result of computations based on several measurements of angles and distances. In light of this, it is a constant source of wonder that so many real property boundary dimensions are the same from survey to survey.

6.7. COLONIAL PERIOD

Perhaps the best way to clarify the impact of measurement methods, procedure, accuracy, and reliability on modern real property parcels is by reviewing how the procedure and precision of the past compare with those today. For the purpose of illustration, let us imagine that a particular boundary in colonial America had each end of the line marked by six-inch square stone monuments. The Land Surveyor in 1770 may have been required to produce a survey plat (Figure 6.1) to assist in the identification of the parcel to be transferred to private hands.

The Land Surveyor probably would have used the following method to determine the distance between the corner markers: Because the line in question is a boundary line, there would probably be a fence or a hedgerow along the entire length of the line. The Land Surveyor would, therefore, clear a line parallel with the boundary at some convenient distance from the actual line. Temporary wooden pegs might have been set at each end of the cleared line opposite the stone corner markers. These pegs would have marked the ends of the segment to be directly measured.

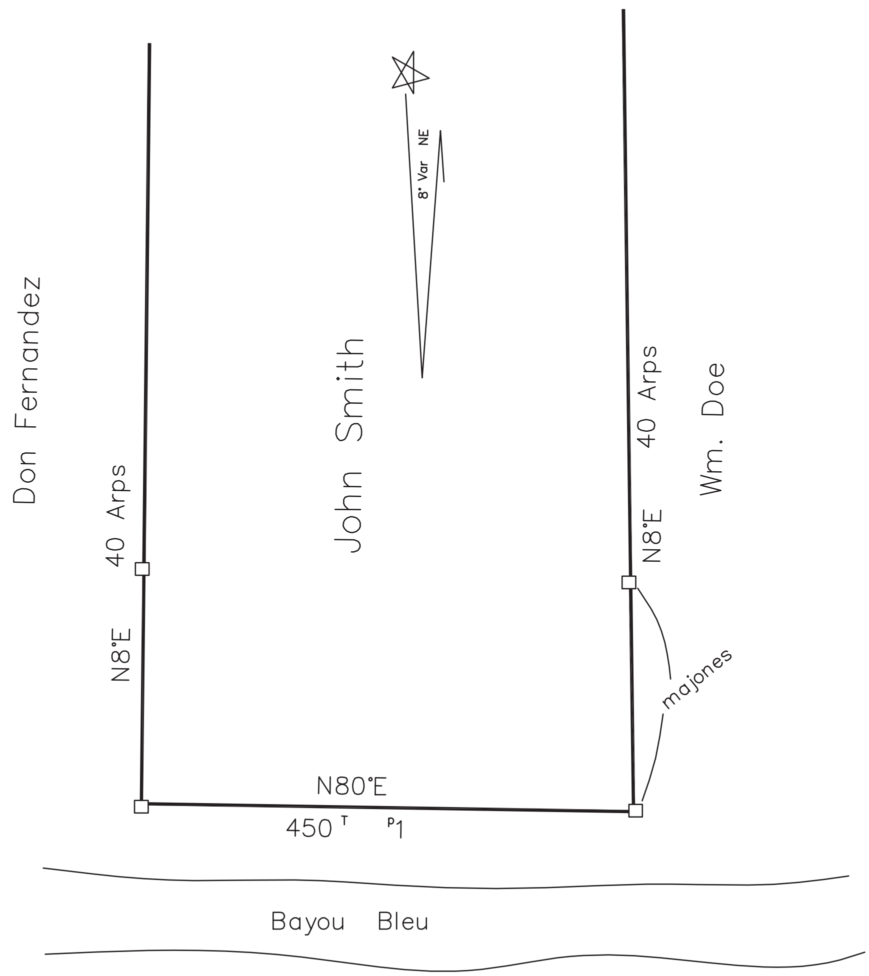

FIGURE 6.1

Although a Gunter's chain might have been available, a device called a "compass" or a "toise" might have been used to measure the distance between the pegs of the offset line. Figure 6.2 provides a sample of how a toise might have been constructed. Depending on where in colonial America the land was located, the dimensions of the toise would have varied from about 6 to 6.4 feet. The device would usually have been made of wood by the Land Surveyor himself. The points might have been metal tipped or simply sharpened wood.[3]

[3]In other areas, a pole or a rod $16^1/_2$ feet long and possibly capped with brass ends was commonly used to measure distances.

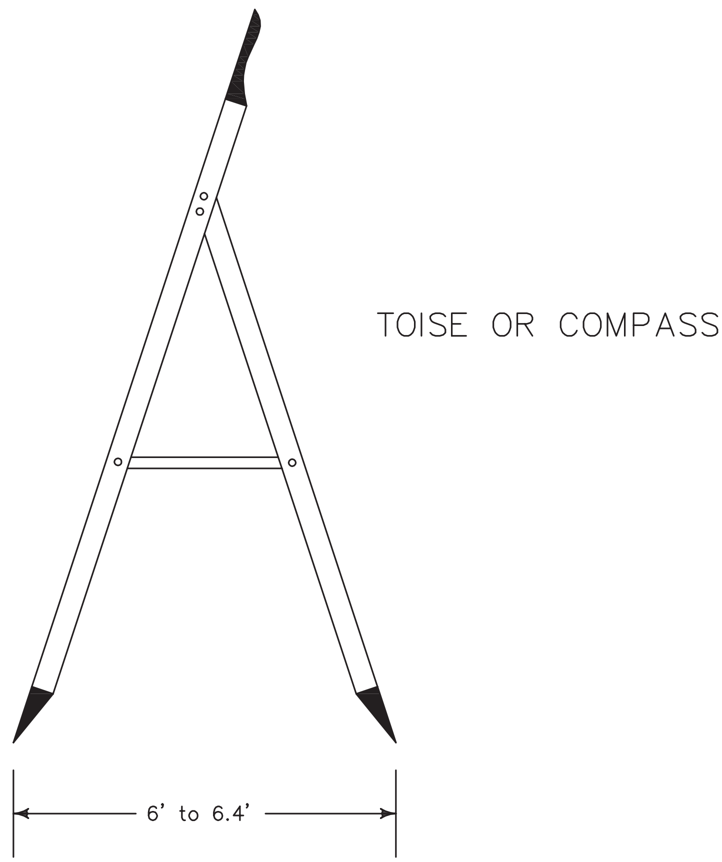

FIGURE 6.2

The Land Surveyor would have begun the measurement by placing one end of the toise at a peg and the other end of the toise on the ground in line with the far peg. The device would then have been rotated about the leading tip so that the trailing tip would be brought to the leading position and in line with the far peg. The process would be repeated, alternating the tips of the toise until the far peg was less than one rotation from the leading tip. This remaining portion would be measured with a yardstick, a foot rule or simply estimated.

An examination of this process reveals several sources of measurement error or inconsistencies. Any slight failure of the toise to be exactly the correct length would be repeated for every measurement. If, for instance, the distance between the tips were an eighth of an inch shorter than the six feet it was believed to be, then the surveyor would have reported a mile (5,280 feet) measured when only 5,270 feet, 10 inches had actually been traversed.

Each rotation of the toise would have to have been without any slippage. Any movement of the tips during the act of transferring the trailing tip to the leading position would introduce error. The work would often be done from horseback, adding another factor to the difficulty involved in simply rotating the device. Each tip would also have to be set perfectly in line with the end pegs, or additional error would be introduced.

The toise would have been set directly against the surface of the earth, so every rise and fall in the land would have added apparent distance to the measurement. The Land Surveyor would sometimes have attempted to account for this increase in distance by estimating the amount of extra turns the changes in elevation caused. The practice of "adding one for good measure"—that is, deliberately adding an unreported turn on the toise or adding one more length of rod to prevent "shorting" the buyer—was very common, especially in hilly country.

The beginning peg and ending peg would have been set in locations estimated to be directly across from the end points. This estimation would introduce error that could be quite large if the offset line were some distance from the boundary line. The Land Surveyor would have recognized that the measurements made by him were far from perfect, and so the slight error introduced by estimating the offset peg locations would be considered acceptable. In cases of original surveys, meaning surveys that created new parcels, the lines run might have been the actual boundaries.

In measuring one mile, the Land Surveyor would have to have made 880 rotations of a six-foot toise. It would have been highly possible, even probable, that occasionally a miscount might have occurred. Often, lines were measured several times to avoid miscount blunders, but just as often they were not. This factor alone introduced considerable doubt about just how much reliance could be placed on surveys conducted in this manner.

The direction of the boundary line would be determined by placing a magnetic compass at one offset peg and sighting the other. The bearing of each boundary line would be determined in the same way. The angles formed at the corners would not be measured in most cases.

The preceding scenario assumes that the end points or offset end points were intervisible. If the intervention of hills or woods made it impossible to see one corner post from the other, the problem of aligning the route of the offset line would be much more complicated.

In this case, a magnetic compass would be used to maintain line as well as to determine direction.

If the end points were not intervisible, the Land Surveyor would set a magnetic compass over one offset peg and send a rodman as far ahead on the line as could be seen, using the compass bearing believed correct for that boundary. The distance to the rodman would be measured as before, and the compass would be brought ahead to the rodman. The rodman would then be sent ahead again and the process repeated until the end peg was reached. The distance from the offset line at the end of the segment being measured would be noted, and corrections to the reported bearing would be made if the end offset was significantly different than the starting offset.

If the work being done was the creation of a new parcel, then the actual boundaries may have been traversed in a consecutive sequence such that the Land Surveyor would begin the work at one corner (the point-of-beginning) and measure the bearing and distance of each side, in order, returning to the point-of-beginning. If the new parcel was to be *a specific size* then one additional step would be added.

Because the new parcel being created represented a bounded area, the Land Surveyor would know that, if the measurements were perfect, the last line measured would return to the point-of-beginning. Of course, perfect measurements are impossible, so the last line measured would never return to the exact point-of-beginning. The most common method used to address this problem would have been the "field correction."

After the Land Surveyor had satisfied himself that some gross blunder had not occurred, the field correction would be applied. This correction usually would consist of adjusting the location of one or more of the survey marks until the *distances* called for were satisfied. In Figure 6.3, the attempt to return to the point-of-beginning resulted in arriving at the point labeled "end." In this case, the Land Surveyor might have applied the field correction by simply moving the point labeled "3" northeast 25 feet.

Each Land Surveyor had his own preferred method of applying field corrections, and, in most cases, these corrections were applied based on the Land Surveyor's judgment, not on any scientific analysis.

The procedures outlined were representative of the type of work that was done in the latter part of the 18th century. The actual practice in any particular part of the country varied greatly. The notes, letters, and drawings of the Land Surveyors of that period and jurisdiction would be the best source of information on actual practice in that area.

Plats often hold clues to the procedure used. Because of the uncertainties involved, the distances reported by these early Land Surveyors

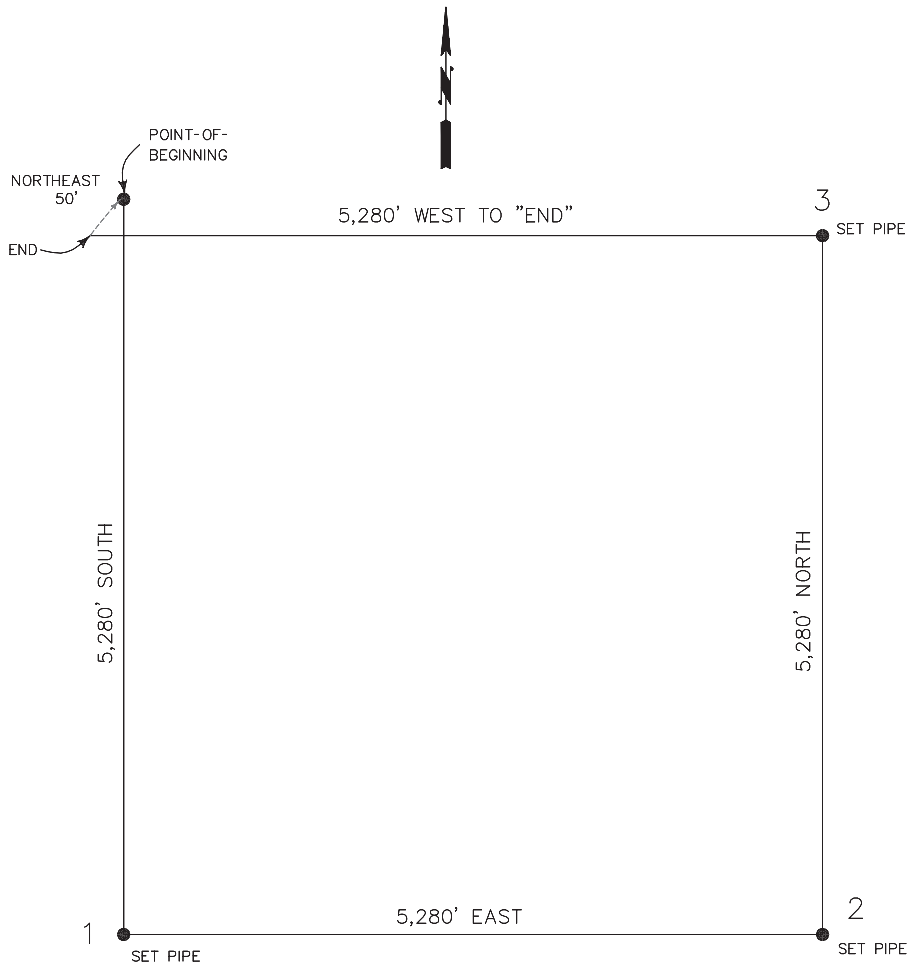

FIGURE 6.3

could not be expected to be more accurate than one foot in 100. The bearings shown are even less reliable because of the lack of precise sighting devices and reliance on magnetic north.

The concepts of errors in measured values were well known in the 18th century. The degree to which the methods of accounting for these errors were applied is a reflection of land values, craftsmanship, and skill or sophistication. Multiple observations might have been used to eliminate blunders. Skilled craftsmanship could have reduced the magnitude of systematic errors. But the greatest tool in the detection of errors, the analysis of results, was not very effective in the 18th century because the measurements of direction were so crude compared with the measurements of distances.

If one were to measure a closed area, such as a parcel of land, a mathematical analysis of the distances and directions reported could determine if the values presented were consistent with each other. During the 18th century, the crudeness of the directions observed, the laboriousness of the computations, and the low value of the land meant that these methods were rarely applied.

6.8. POST–CIVIL WAR PERIOD

If the imaginary boundary shown in Figure 6.1 were resurveyed a century later, there would have been only a few changes in the survey procedure. The existence of a fence line or a tree line along the boundary would have still required the use of the offset survey line. Pegs would have been set at estimated right angles to the boundary line a short distance from the stones just as 100 years ago.

The Land Surveyor of 1870 probably would have used a variation of the Gunter's chain, called the "two-pole chain," to measure the distance between the end pegs. The Gunter's chain was an iron chain of 100 links that was 66 feet long. Figure 6.4 is a detail of a portion of a Gunter's chain.

The figure is based on an antique that had tags on each link, which was not a common practice. Link tags were more commonly set at 10-link intervals or more. The two-pole chain was a shortened version of the Gunter's chain and was 33 feet long and had 50 links. A two-pole chain was laid out twice to measure one "chain" of distance.

The measurement of the distance began in the same way as the 1770 survey. One end of the chain was held over the starting peg, and the chain was stretched ahead, supported at the ends only. If the ground was

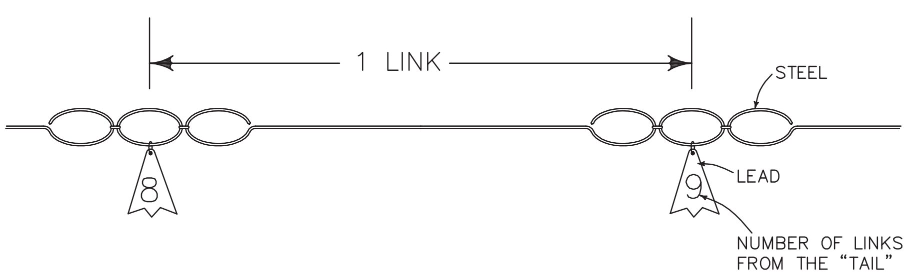

FIGURE 6.4

sloping, the ends were held such that the ends of the chain would be at roughly the same elevation. This was done so that only the horizontal distance was measured. The end of the chain was marked by a pin, and the chain was moved forward. Alignment was maintained by sighting the end points, if possible, or by sighting the bearing of the line with a magnetic compass.

The common sources of errors in the process were well known, and some attempt at compensating for these errors was often made. The chain length was subject to wear because the chain links rubbed together. Often, a standard chain was kept at the home office for comparison with the field chains. The sag of the chain supported at the ends varied with the force exerted by the chainmen. The marking of the chain ends by pins sometimes included guesswork as to where the ends actually were, especially in rough terrain. Failure to measure in a straight line also introduced error.

The sighting devices on the Land Surveyor's compasses were improved, and the introduction of the solar compass slightly reduced some of the uncertainty associated with magnetic directions. Generally speaking, the state of the art had advanced to the point where distances measured were accurate to one foot in 500. Directions were probably accurate to one degree, although failure to account correctly for magnetic deviations still rendered this part of the Land Surveyor's work the least accurate.

The slight improvement in determining directions also improved the effectiveness of analysis of results in detecting errors. Although mathematical analysis was possible, time, cost, and the specter of laborious computations meant that any analysis of results usually took the form of plotting the parcel to scale to determine if it "closed." The use of mathematical analysis did begin to increase with the approach of the 20th century. This is not to say that rigorous mathematical analysis of survey results did not take place prior to the 20th century; only that it was not commonly used. Figure 6.5 shows how that same parcel might have been platted in 1870.

6.9. BEGINNING OF THE MODERN PERIOD

By 1920, the introduction of the Surveyor's Transit[4] into everyday survey work had corrected some of the shortcomings that had hounded

[4]In America, this term is used to identify a theodolite that is read by use of a vernier scale and has a telescope that can be inverted (transited) without removing it from the instrument.

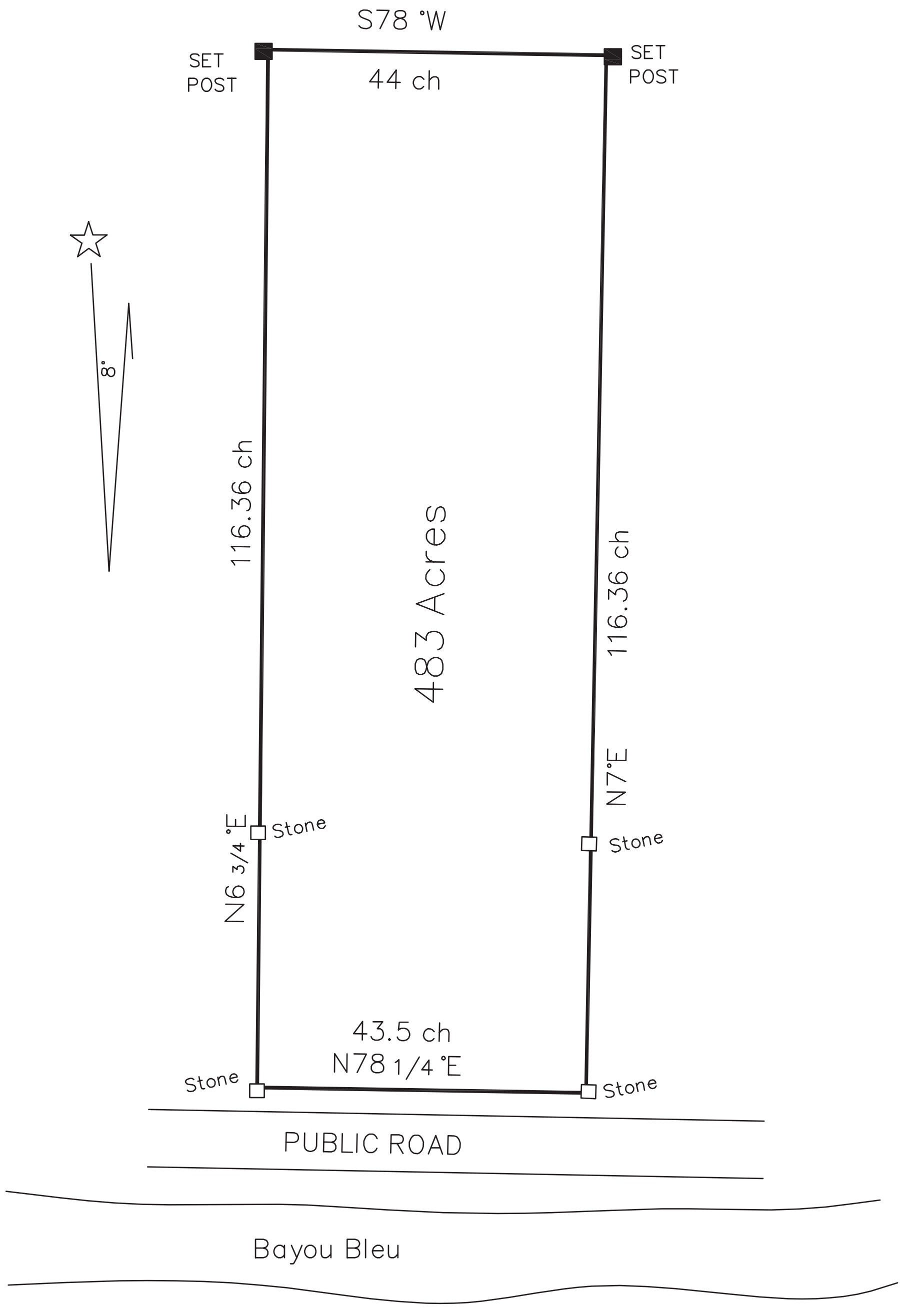
S78 °W
SET POST
SET POST
44 ch
8°
116.36 ch
483 Acres
116.36 ch
N7°E
N6 3/4 °E
Stone
Stone
43.5 ch
N78 1/4 °E
Stone
Stone
PUBLIC ROAD
Bayou Bleu

FIGURE 6.5

Land Surveyors in the past. Instead of observing independent bearings for every line of a boundary, the Land Surveyor now measured the angles *formed at the boundary corners*. This greatly increased the reliability of the reported shape of the parcel of land being surveyed, which greatly increased the accuracy of the acreage computed, but it did not improve the reliability of the magnetic direction used to orient the survey.

Distance measurement was much the same as in 1870, except that a steel Surveyor's Tape (still called a "chain") measured the distance in feet and decimals of a foot. The actual distance measured was still between offset points. The relationship of the offset points to the corner monumentation was now more accurately known because of the use of the transit to measure the angle to the actual corner. The steel tape was laid out and the lengths marked with chaining pins exactly as the two-pole chain had been used. Figure 6.6 shows how our imaginary parcel might have been platted in 1920.

The introduction of the transit enabled the Land Surveyor to measure accurately the angles formed by the intersecting boundaries of the parcel instead of simply measuring the independent bearings of each side. This increased the accuracy of the typical survey of the day to the point where deviations of less than one foot in 5,000 were common. For most work of the early twentieth century though, the accuracy of one foot in 1,000 for distances and one minute of arc for angles is about the norm.

The introduction of the transit to measure angles also meant that the mathematical analysis of the distances and angles measured became a very useful tool in determining the validity of the results of a survey. The concept of "closing a traverse" became widespread. If a parcel of land were measured by linking all of the lines around the parcel, then a Land Surveyor might compute the changes in distance and direction that took place if he or she were to travel from one corner to another in consecutive order. This "traverse" would return the Land Surveyor to the exact point-of-beginning if all of the angles and distances were error free (assuming a proper plane projection was used). The amount by which this traverse failed to return to the point-of-beginning would then be the sum of all the measurement errors: systematic, random, and blunder.

If a blunder occurred, then a large failure to close would have been noted (unless two blunders in opposite directions occurred, in which case one might hide the other). If the failure to close was within an acceptable range, then the Land Surveyor would "balance" the computations by simply distributing a "correction" to each angle and distance

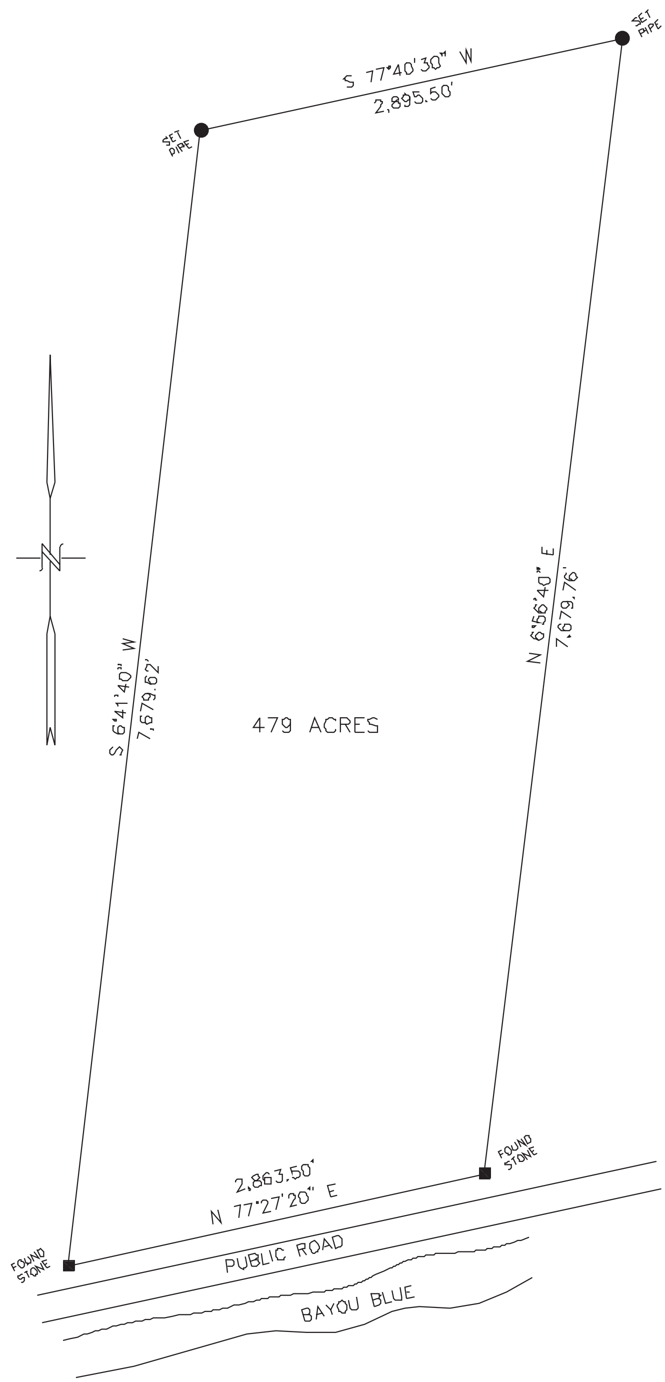
SET PIPE
S 77°40'30" W
2,895.50'
SET PIPE
S 6°41'40" W
7,679.62'
479 ACRES
N 6°56'40" E
7,679.76'
FOUND STONE
2,863.50'
N 77°27'20" E
FOUND STONE
PUBLIC ROAD
BAYOU BLUE

FIGURE 6.6

measured until the figure did "close" upon mathematical analysis. Variations of these methods of "balancing the traverse" are used today but with greater sophistication (we hope).

The most common methods of "balancing a traverse" generally available were, and still are, the compass rule, the transit rule, Crandall's rule, and the least squares adjustment. Notice that the first three methods are identified as rulesand the last is identified as an adjustment. All of these methods, with the exception of the least squares adjustment, require the use of a plane projection system, where each point can be defined by plane coordinates. Least squares adjustments can be applied to any set or group of measurements, regardless of the mapping or computational control used.

6.9.1. Compass Rule

The compass rule was, by far, the most popular method of balancing a traverse during the early and mid-20th century. It is still quite popular today and, under certain limited circumstances, is still a valid method.

In Figure 6.7, the measurements made by the Land Surveyor on the example triangular traverse are shown. It is known that the interior angles of a closed figure must add up to a particular value; in this case, 180 degrees. The sum of the measured values is 179 degrees, 58 minutes, 48 seconds, indicating an error of 1 minute, 12 seconds. The first step in applying the compass rule to this case would be to divide the total angular error by 3 and add this number to each of the three measured values. This adjustment of angular error is made *before* any other computations are made. Figure 6.8 shows the "adjusted" angles of the example traverse. Note that no correction is made to the angle from "north" to the line "A–B."

Using the adjusted angles, a plane projection bearing of each line is computed. These bearings are then used to compute the location of each of the corners based on the distance north (or south) from the point-of-beginning. This distance is sometimes called "latitude" when it is referring to the change from one point to the next. Similarly, the location of each comer based on the distance east (or west) is computed. This distance is sometimes called the "departure" when it is referring to the change from one point to the next.

All computations are two-dimensional and are made on the theoretical plane of the map projection, even though the three-dimensional terms of *latitude, longitude, north,* and *east,* among others, are frequently used.

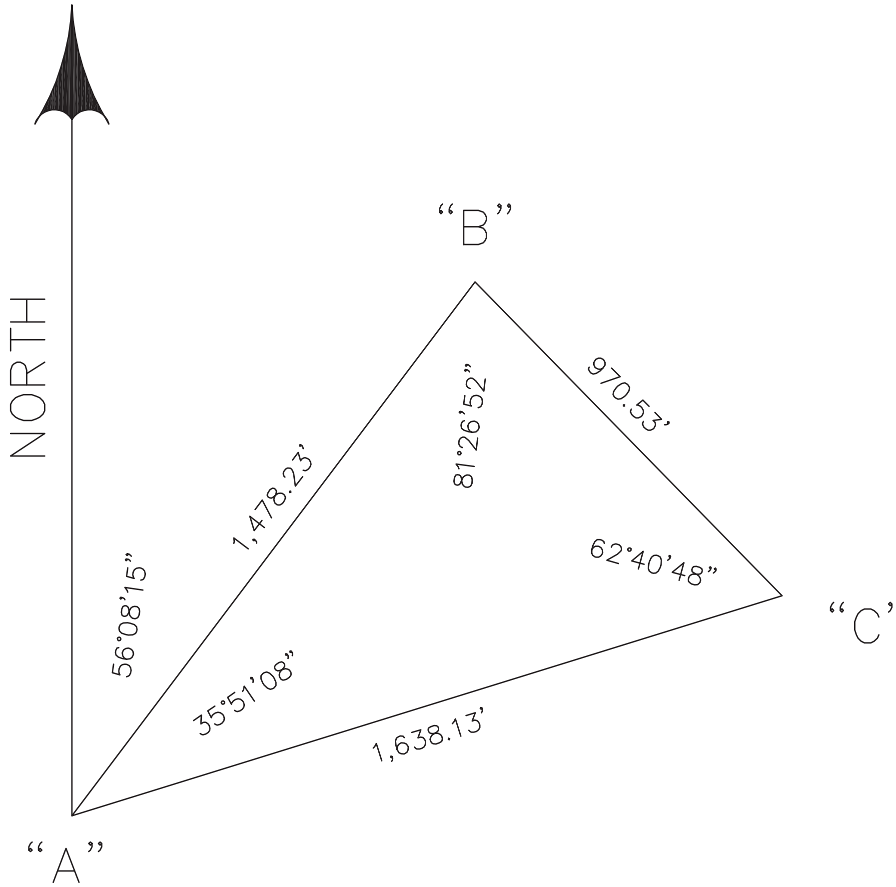

FIGURE 6.7

Consecutive computations of each point in the traverse will result in two sets of values for the point-of-beginning: the first set being the values assigned at the beginning of the computations and the second set being the values computed at the end. The difference between the original values and the computed values, or failure to close, has a north–south component and an east–west component. The compass rule states that a correction will be added to (or subtracted from) the computed coordinates of each point in proportion to the accumulated distance from the beginning, measured along each side, divided by the total distance around the traverse.

If, in the example traverse, point "A" were given the initial value of 0 feet north and 0 feet east, then the following table gives the initial computed values for the points shown, rounded off to the nearest one

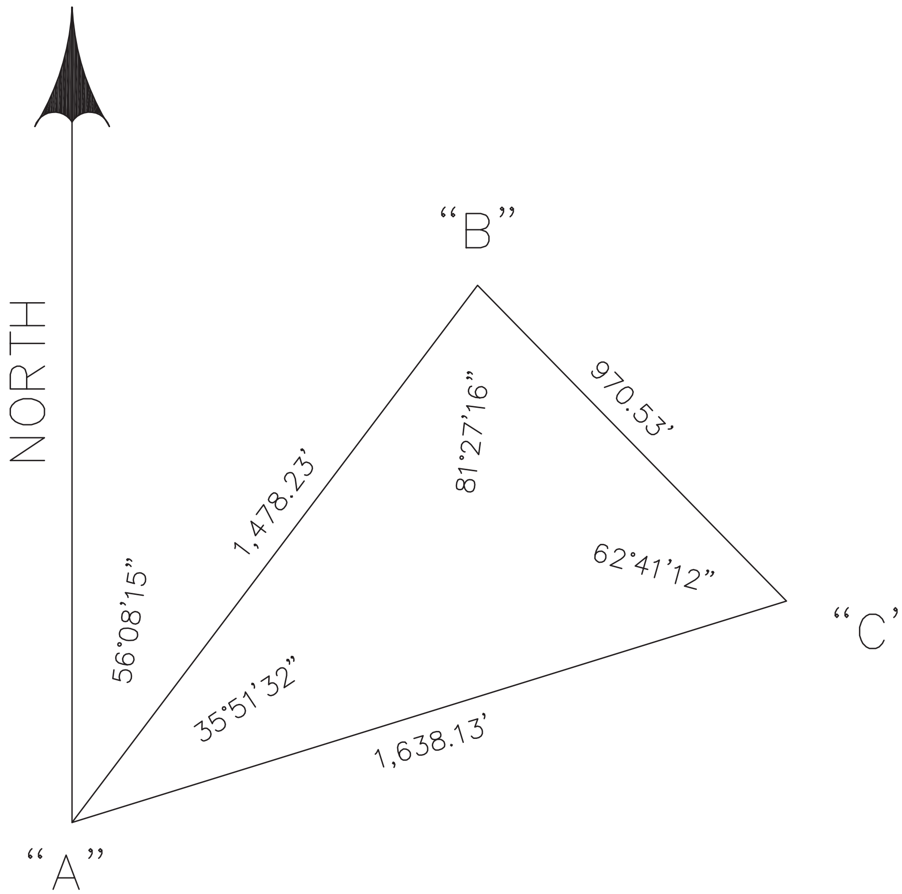

FIGURE 6.8

hundredth of a foot. A negative value in the "Feet North" column indicates south; in the "Feet East" column, it indicates west.

Point	Feet North	Feet East
"A"	0.00	0.00
"B"	823.67	1,227.49
"C"	−53.65	1,642.51
"A"	3.43	5.38

In order to "correct" the value for point "C," it is necessary to subtract 2.06 from the north coordinate [3.43 × (1,478.23 + 970.53)/(1,478.23 + 970.53 + 1,638.13)] and subtract 3.22 from the east coordinate [5.38 × (1,478.23 + 970.53)/(1,478.23 + 970.53 + 1,638.13)]. The

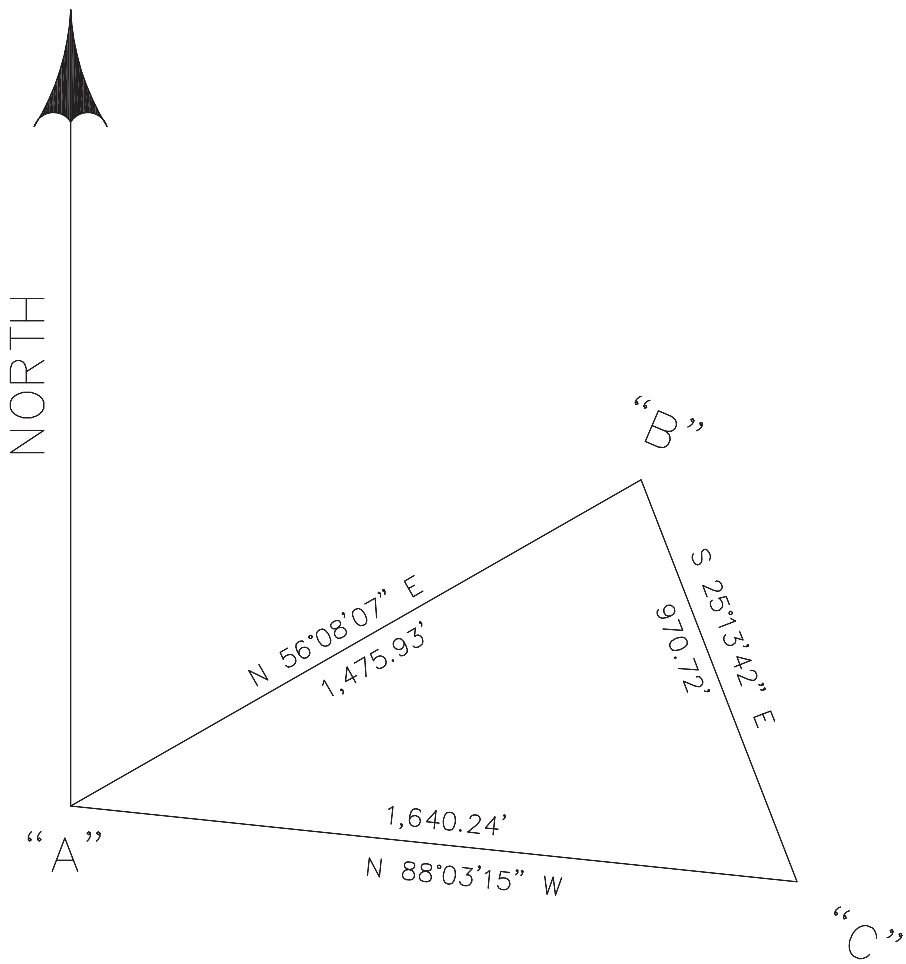

FIGURE 6.9 Adjusted Traverse

coordinate for "C" can be "adjusted" to north –55.71 feet and east 1,639.29 feet. Each point in the traverse is corrected in this manner.

Once the coordinates are adjusted, the distances and directions between each point can be *computed* based on the adjusted coordinate values. Figure 6.9 shows the example traverse after an application of the compass rule.

The *adjusted values* are used in all reports, other measurements, locations, and descriptions of the parcel being surveyed. Unlike the field correction, *no points are moved*. The only change that takes place is in the values assigned to the directions and distances of the lines.

One of the most common mistakes made in applying the compass rule is the failure to adjust the measured angles *before* the initial computation bearings and coordinates. This blunder, while resulting in an adjusted traverse, yields a different adjustment for the same traverse computed clockwise than counterclockwise. Another common misconception is that the compass rule adjusts the traverse based on the probability that certain measurements will have greater error involved than others. In truth, the compass rule, like all the "rules," only *makes things fit*.

6.9.2. Transit Rule

The transit rule also begins with an adjustment of the measured angles in the exact manner as the compass rule. Just as in the compass rule, the initial bearings of the sides of the traverse are computed from these adjusted angles. The coordinates of each point are computed using the measured distances and the adjusted bearings. The difference between the compass rule and the transit rule is in how the failure to close is proportioned to each coordinate.

The transit rule uses the ratio of the changes in north (or east to correct the east coordinate) for a particular line to the arithmetic total of the changes in north (or east for the east coordinate) and adjusts each latitude (or departure) of each line accordingly. This adjustment method was quickly recognized as one that produces inconsistent results, and so the use of this method has been, for the most part, discontinued.

6.9.3. Crandall's Rule

Crandall's rule was an attempt to apply the concepts of probability to error correction. According to this rule, errors in long distances are more probable than in short distances, and errors in distances in general are more probable than errors in angles. The application of this rule is a fairly complex computational procedure that essentially ignores angular errors and disproportionately adjusts distances. Crandall's rule almost always results in adjustments that are unnecessarily distorted, so the use of this procedure has generally been restricted to academicians.

6.9.4. Least Squares Adjustment

The least squares adjustment of a traverse is one of the many applications of the theory of least squares analysis of measured values. Unlike the rules cited earlier, the least squares adjustment is strictly based on the theory of the propagation of measurement errors. The theory states that, for any set of measured values, the best set of corrections to apply to the measured values is one such that the sum of the *squares* of all of the corrections is minimized. The least squares adjustment is the most commonly used method of adjusting measured values.

The simplest example of the least squares adjustment theory is the average. If the least squares theory is applied to a single set of things that are measured many times, calculus renders the arithmetic average as the least squares solution. If the distance between two points were measured many times, then the average (obtained by summing all of the measurements and dividing by the number of measurements made) would represent the most probable measured distance. Every person has, at one time or another, used a least squares adjustment without knowing it.

The least squares adjustment is applied directly to measured values and, in surveying, is simplest when the precision of angular measurements is comparable to the precision of the distance measurements. If the procedure used to measure the angles (distances) is much more precise than the procedure used to measure the distances (angles), then special steps within the least squares adjustment must be taken for the results to be valid.

Unlike the rules, the angles of the traverse are not adjusted prior to beginning the least squares procedure. Angles and distances are adjusted simultaneously, based on the theories of probability. The procedure renders consistent and reliable results in proportion to the quality of the measurements made.

6.10. MODERN PERIOD

From the mid-1970s to today, the increased use of electronic distance measuring devices (EDMs) has greatly increased the accuracy of the distances reported on modern surveys. Unlike the toise or the chain, the EDM does not rely on repetitively “laying out” a standard length. Most EDMs measure distances by emitting a laser light that is reflected back to the instrument by a special mirror. The distance to the reflector is determined by comparing the departing signal with the returning one.

The accumulation of error with every length of chain, so inherent with the old methods of measurement, is almost absent with the EDM. It is only necessary to be able to see from one end of the line segment being measured to the other in order to measure the distance.

The high precision of the EDM has matched the precision long possible in angular measurement. This "matching of precision" is perfectly suited to the least squares adjustment method of analyzing measured values. When the distance values were obtained by chaining, even when strict procedures were used, the angular values were usually more reliable. The Land Surveyor had to determine the relative degree of difference in reliability in order to use the least squares adjustment method properly. This difficulty, which discouraged the use of least squares, was eliminated by the EDM.

Distances of several thousand feet are measured as quickly and as easily as a few feet. This has also led to a more widespread acceptance and use of the state plane projection system by the Professional Land Surveyor. Full use of state plane system requires that the work be tied into control stations that may be miles from the job site. Before the accuracy and ease of long-distance measurement were provided by the EDM, one could hardly fault the Land Surveyor in private practice for opting not to spend several extra days on a job just to tie it to the state plane system.

GPS instrumentation has increased this long distance measurement capability to distances that are truly global. The near distance precision of GPS-based systems is marginally less than that of the EDM, but on the scale of miles it is unparalleled. This development alone has all but mandated the acceptance of state plane controlled surveys by the professional community.

The introduction of the computer has allowed the Land Surveyor to use formerly very cumbersome, but theoretically superior, computational methods of detecting error distribution and balancing traverses. Now, instead of using guesswork in identifying and correcting for errors, complex and sophisticated mathematical procedures are available to every Land Surveyor. The formerly time-consuming tasks of computing traverses, areas, distances, and a thousand other things are now performed in fractions of a second. This relief from tedium has allowed the Land Surveyor the opportunity to look at every problem from many different sides.

Modern surveys are performed with a degree of precision that was nearly impossible just a few decades ago. Accuracies of better than one in 70,000 are now commonplace. Angles and distances can be measured with equivalent degrees of accuracy. This results in a greater consistency or reliability of computed dimensions. This is perhaps best illustrated by the standard deviations for typical modern instrumentation listed in Table A.5 in the appendix of tables.

The future of survey measurements—that is, the tools and procedures—that will be available to the Land Surveyor are unlimited.

Already, unimagined combinations of many differing aspects of the electronic era are happening that effect many of the ways that data can be collected.

Three-dimensional digital scanning, which combines photography with special control and digital archiving, is only one of many promising new technologies. The collection of data is being automated to the point that it is almost overwhelming. The effort, considerations, and judgment that the Professional Land Surveyor must exercise today require an ever-increasing level of education and wisdom.

6.11. RANDOM TRAVERSE

In order to illustrate better the impact of these modern advances on the profession of surveying, let us recreate a typical boundary survey of a simple fictitious parcel of land. Figure 6.10 shows the corner monuments of the parcel in their relative positions. The methods used to recover these corners will be discussed in detail in Chapter 10. The corners are the limits of the parcel, and the task at hand is to *measure* the distances between the corners, the angles formed, and the area of the parcel. Knowing how this is typically done today will greatly enhance your understanding of boundary surveys.

Because the property involved is valuable and because of the expected use of the property, the Land Surveyor, in our example, has decided to use the local state plane coordinate system to control and map the survey The Land Surveyor may have previously established a "control traverse" between two National Geodetic Survey (NGS) stations, "Billy" and "Bob," as a part of another job. The latitude and longitude of "Billy" and "Bob" are published by NGS and are the results of measurements that have been *adjusted to conform* to the national network. The latitude and longitude of these stations have been mathematically translated to the appropriate state plane grid coordinates (x's and y's), called the "values" of the stations.

If NGS stations were not available in reasonable proximity to the property, the modern Land Surveyor would use GPS instruments and procedure to establish stations near the project that would be the foundation for the state plane referenced data collected during the survey.

The prior work was one of high precision and was rigorously adjusted to the national network. This means that the measurements of the traverse that were used to develop the "x" and "y" values for each traverse station were strictly controlled and that these values were *adjusted* to conform to the published values of "Billy" and "Bob."

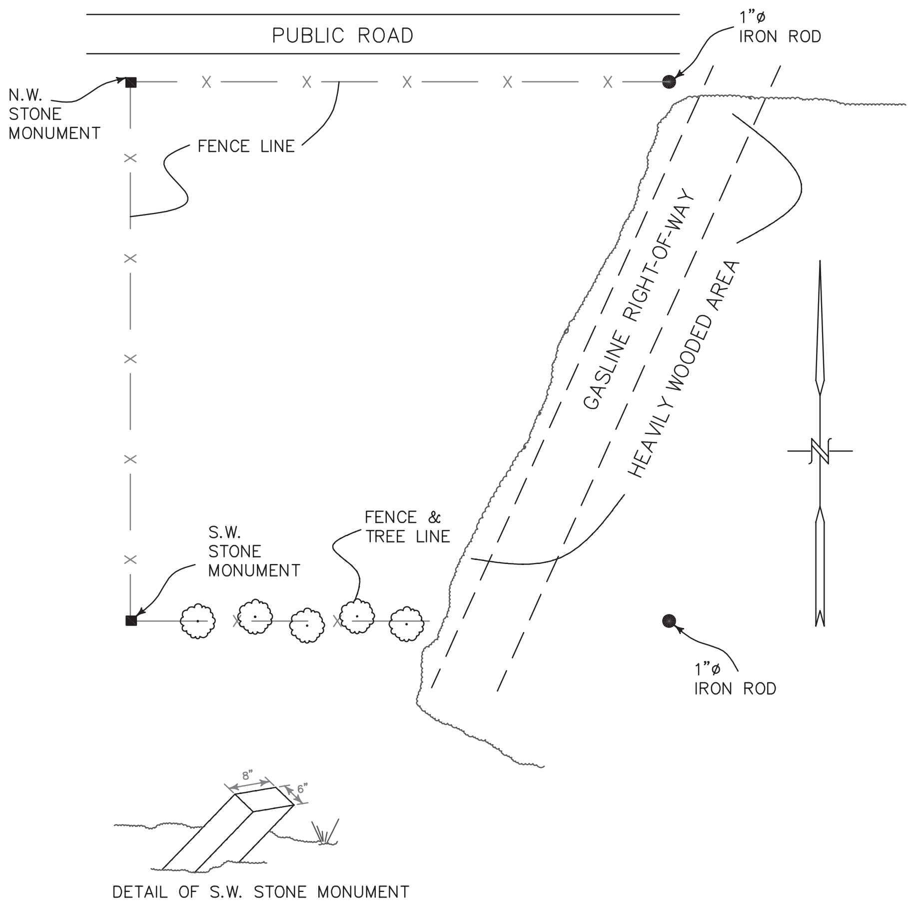

FIGURE 6.10

Consequently, the distances and angles actually measured in the traverse are not exactly the same as the distances and angles indicated by the assigned values of the stations. This variation between "measured" and "reported" is very small because of the high precision involved. Figure 6.11 shows the relationship of this traverse to the parcel being surveyed. The traverse stations are often called "random," because they were chosen for reasons of convenience, observation, permanence, and other factors. Traverse stations do not directly represent real property boundary corners.

The land between the corner monuments consists of hedgerows, fence lines, heavy woods, hilly terrain, and other obstacles that prevent direct measurement between the corners. Therefore, the Land Surveyor must establish a secondary control traverse that takes advantage of

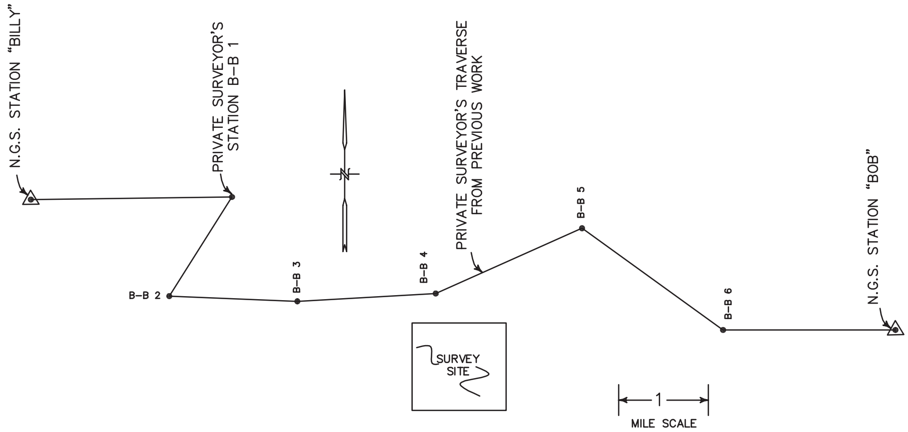

FIGURE 6.11 Random Traverse

roads, power lines, pipelines, cleared fields, or other features that allow for unobstructed lines of sight.

The points at which the secondary traverse changes direction are typically called "control stations" or "random stations." The locations of these control stations are deliberately chosen so that features that are to be recorded are near or, at least, visible from one or more control stations. Figure 6.12 shows the secondary control traverse for this example.

Angles 1 through 6 were measured using procedures and equipment that resulted in quantities that were expected to vary from the actual value less than 5 seconds either way. Distances 1 through 5 were measured using procedures and equipment that resulted in quantities that were accurate to within 1 in 70,000. The coordinate values of each of the secondary stations are then computed and adjusted using the least squares method of traverse adjustment to conform to the values of stations B–B 4 and B–B 5. Once again, the adjustment must be within certain limits to be consistent with the level of precision required.

The corner monuments are then tied into the secondary traverse by measuring the angle and distance from the secondary stations to each corner monument. These ties must be multiple and redundant to avoid the possibility of blunder. *Multiple* means that the angles and distances must be measured several times. *Redundant* means that separate sets of measurements must be made wherein any one of the sets is sufficient to compute a value for the corner. The coordinate value for each corner is computed separately for each set of measurements, and the results are compared for consistency. The results are usually combined and

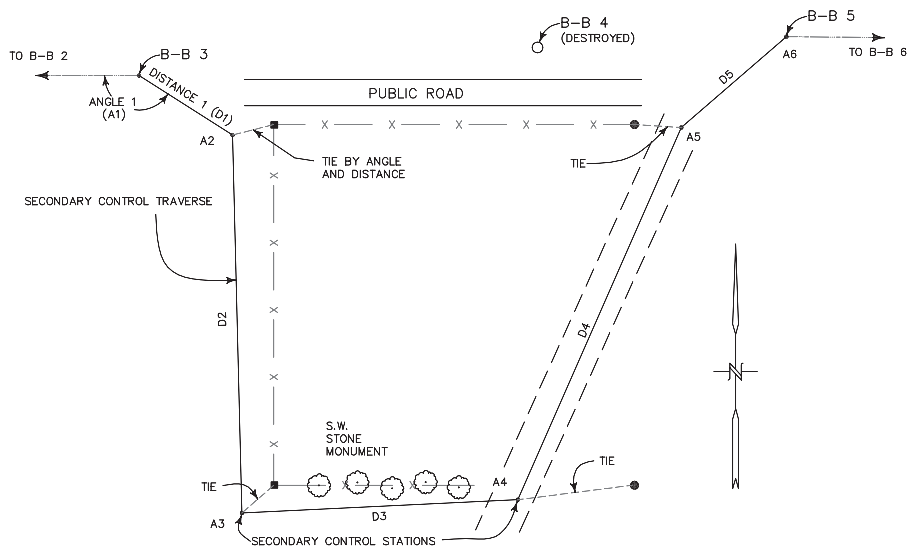

FIGURE 6.12 Secondary Traverse

averaged to produce the accepted coordinates for each of the corner monuments.

Once the coordinates for the corner monuments have been determined, it is a simple matter to *compute* the bearings and distances between each of the corners. The area of the parcel is also computed directly from the coordinates. The state plane projection requirements for accounting for the curvature of the earth and the conversion to and from grid distances are made during the process of the computations so that a map of the parcel can be produced that shows the grid bearings of the lines, the level surface distances between the corners, and the level surface area of the parcel.

It is important to note that the preceding example produced quantities for directions and distances that were based on a series of measurements that had been repeatedly adjusted in an attempt to account for errors. The condition of the corner stones was such that an interpretation was required to determine the former, upright location of the stones. If a second Land Surveyor were to clear the line between two of the stone corner monuments of the example parcel and directly measure the distance between them, the distance reported as a result of the direct measurement would be expected to vary slightly from the distance reported by the first Land Surveyor. Moreover, if a third Land Surveyor were to measure the same distance between the same two monuments, directly, the results of that third measurement would vary slightly from the others.

If anything is learned from this example, it is that angles and distances reported on all survey plats and maps are the results of measurements and are never absolutely "correct."

The modern survey, as in the preceding example, has reduced the uncertainties of the angles, distances, and areas reported by the Land Surveyor to a minimum. Compared to the methods used during the late 19th and early 20th centuries, when most of the titles of private property were developed, the modern survey is vastly more accurate and, consequently, more reliable. The laws governing real property transfers recognize the uncertainty of measurements made by Land Surveyors and operate effectively in spite of these ancient deficiencies.

This short history of measurement systems emphasizes the third,[5] and most compelling, reason for the canon that boundaries are defined by the location of the corners.

If boundaries were defined by directions and distances, every improvement in the science of measurements would move boundaries!

6.12. ELEVATIONS IN THE MODERN PERIOD

Land Surveyors have always been aware of the role that changes in elevations (vertical distances) play in measuring and mapping real property parcels. Until very recently, the interest in the elevation of a property parcel was rarely associated with a national datum. Landowners were interested only in relative elevations. Was the property hilly or flat? Was the land subject to frequent flooding? These and other questions relating to relative elevation were rarely part of the real property deed documentation and were usually reserved for the inquiry of sophisticated buyers.

The process used to measure the differences in elevation has changed little in the last century, in spite of all of the other advances in technology. The greatest change has been one of regulation, not science. Federal, state, and local regulatory authorities have intervened in the process of real estate transactions. Federal flood insurance programs, lending agency policies, and state and local regulations have added requirements for information that go far beyond the traditional documentation of real property parcels. The absolute elevation of structures relative to a specific datum is now a common requirement of many regulatory agencies.

[5]The first reason that corners define boundaries is ancient tradition. The second is the need for regular shapes on an irregular planet.

Before an agency can require elevation data pertaining to a real property parcel, that agency must establish or specify the datum to be used. The federally defined North American Vertical Datum of 1988 (NAVD 88) (see section 3.8) has become almost universal as the datum of choice for all regulatory bodies. Many regulatory agencies refer to NAVD (formerly National Geodetic Vertical Datum [NGVD]) elevations as a requirement without understanding the least bit what is involved. The process of measuring the NAVD value of the elevation of a structure and the foundation of that data need to be understood if that information is going to be used in a beneficial way.

In the past, the NGS had established a series of "bench marks," which are simply specific locations that have a published elevation associated with them. A typical bench mark is a brass disk clamped onto the end of a very long rod (often 150 feet long). The rod is driven into the ground or otherwise fixed to the earth at what is hoped to be a stable site.

The differences in elevation between all of these bench marks are measured using differential leveling procedures that are a sophisticated version of the Land Surveyor's ordinary level and leveling procedure. These differences in elevation are measured and remeasured frequently. New bench marks were constantly being added, and old bench marks are frequently being destroyed or disturbed. Furthermore, the entire network of bench marks had to be constantly reevaluated and updated.

In the near future, NGS will provide elevations through a network of continually operating receiver stations (CORS). The CORS network will be updated regularly and available to anyone with an Internet connection and a GPS receiver. These stations will eventually replace the bench mark system of establishing elevations. Local and project elevation control will still be supported by bench marks.

The most common method used by the private Land Surveyor in determining the NAVD 88 elevation of a location is differential leveling, using a Land Surveyor's level and level rod. The modern Land Surveyor's level is a device fixed with a telescopic sight that can be mounted on a tripod and adjusted so that the line of sight through the telescope at the center crosshair is perpendicular to the plumb line at the instrument. The level rod is a graduated ruler that, when set vertically on a surface, displays the vertical distances along the rod from that surface.

The process of differential leveling begins at a bench mark or location of known elevation. The level is set up a short distance from the bench mark (usually less than 150 feet), and the level rod is set vertically on the bench mark. The observer then peers through the level's scope and records the value seen on the level rod at the horizontal line of a center crosshair. This value is the measured distance between the surface and the line of sight. If the earth were flat, the value observed on the rod would also be the difference between the elevation of the level and the elevation of the bench mark. The elevation of the level would equal the elevation of the bench mark plus the rod reading.[6]

The rod is then moved to a new location nearer the site to be surveyed (still less than 150 feet from the level) and set vertically on a new surface. The observer again records the value shown on the rod through the sight of the level. This second value is subtracted from the just determined elevation of the level, producing (theoretically) the elevation of the second surface.

The level is then moved ahead, and the process is repeated, using the newly determined elevation of the second surface or "turning point" to compute the elevation of the level at the new location. This process is repeated, in leapfrogging fashion, until the location to be measured is reached.

This laborious and tedious process of differential leveling requires at least 17 instrument setups to "carry" elevations one mile. The initial network of level runs needed by NGS to establish the federal bench mark system consisted of hundreds of thousands of miles!

Unfortunately, elevation information, so laboriously collected, is not permanent. Aside from the changes in elevations wrought by redefining the datum, many regions are experiencing vertical movement in the land itself. Heaving and subsidence of the earth's surface is a common phenomenon in many areas. The elevation of a building is not a constant value but changes with time. Even in areas where there is very little vertical movement, the significance of an elevation value will change.

Land development will change the storm water runoff patterns, often subjecting land to an increased frequency of flooding. The maps used by federal, state, and local agencies to determine flood hazard are often updated and revised, based on changes in the watershed. Elevation information must be current to be of any value.

6.13. FUTURE OF SURVEYING

Several decades ago, indeed within my professional lifetime, the science of measuring angles and distances on the surface of the earth was

[6]The world isn't flat, of course. For that and other reasons, the distance from the level to the rod is kept small. The myriad complications associated with precise differential leveling is far beyond the scope of this book.

not much improved beyond what it was millennia ago. The measurement of angles was dependent on sighting distant objects and interpreting etchings on a circular plate. The measurement of distances was dependent upon sequentially placing an object of known length on the ground and summing the results.

The electronic revolution brought a gigantic improvement in not only the science of measurement, but the computations, record keeping, documentation, drafting, and every aspect of land surveying.

The Professional Land Surveyor of today has been empowered with measurement, computational, and recording tools that free him or her to commit more time to research, investigation, and the art of recovering real property boundaries.

A GUIDE TO UNDERSTANDING LAND SURVEYS
STEPHEN V. ESTOPINAL

CHAPTER 7

LAND RECORD SYSTEMS

Many territorial animals identify land parcels by marking the boundaries with their scent, scrapes, or other physical signs that tell other animals, "This is mine—keep out." The human race is no different from other territorial animals in this respect. The method of marking boundaries most frequently used by humans consists of marking boundary corners with physical objects, such as posts, rocks, pipes, or iron rods, and marking the lines between the corners with fences, ditches, roadways, or tree lines. This is fine for demonstrating to others the physical limits of a parcel of land. This is not adequate, however, when the need arises to define or describe that parcel to others who cannot visit each boundary corner.

The private ownership of land and the statutes that regulate the transfer of that ownership require that each and every separate parcel, public or private, be capable of being uniquely distinguished from all other parcels in writing. The systems of identification used in each state or region vary but usually take some form of one of three basic systems of identification for original tracts. They are the "metes and bounds" system, the rectangular United States Public Lands System, and the Platted Subdivision system.

In many places, or because of interstate ownership of property, variations of these systems are used simultaneously. Each system will be described in detail.

The first system to be employed in the United States was the "metes and bounds" system and is the basis for property identification in most areas settled and in private hands before the Revolutionary War. This system originated at the dawn of civilization and grew to favor in Europe during the 18th century, when the increase of privately owned (and taxed) land prompted governments to develop more accurate cadastre records. The metes and bounds system requires that privately owned land be identified by naming the adjoining owners and physical limits (bounds) of a property, and that a report of the dimensions (metes) be included in the description of the property.

The metes and bounds system of identifying or describing real property has often been erroneously referred to as the "legal description" when, in fact, any proper description based on any of the systems of identifying land parcels is a "legal" description.

The additional requirement that all land transactions be in writing and recorded with some governmental body to assist the local tax collector in developing a record of property owners (and tax debtors) meant that a general description of the property that simply named all adjoiners (bounds) was insufficient. The area (therefore the value) was a part of the record that was most important to the tax collector.

The second system, which affects the majority of the land area in the United States is the United States Public Land System (USPLS). The USPLS is a more regulated, formal system of identifying land parcels than the old European metes and bounds system.

In 1784, a congressional committee, chaired by Thomas Jefferson, proposed a rectangular division that became the Ordinance of 1785 and the foundation of the USPLS. It is very important to remember that the prime purpose of the USPLS was to divide U.S. public land quickly into easily and uniquely identified parcels so that they could be sold and taxed. Although based on field surveys, the precision (accuracy) of these surveys was of the lowest priority.

The third system (platted subdivision) is used throughout the United States and comes into play where large tracts have been subdivided into several smaller lots. In these cases, reference to the lot and/or block numbers or letters shown on a "subdivision plat" is the means by which a land parcel is identified. The subdivision plat is a plan, usually recorded, that specifies the location and dimensions of several parcels of land. A subdivision plat may divide a tract of land that was originally defined by metes and bounds, the USPLS, or another subdivision plat.

In spite of the possibility that any one of the preceding systems for identifying land is sufficient for sale and tax purposes, the tendency throughout the United States has been to add to or supplement USPLS and subdivision plat descriptions with a metes and bounds description for each sale of property. This dual use of property descriptions has led—can only lead—to instances of confusion in cases where the two descriptions conflict. Much of the confusion could he eliminated if land title users would realize that metes and bounds descriptions of USPLS or platted parcels were intended to *supplement* the description, not *supplant* it.

7.1. METES AND BOUNDS SYSTEM

The first settlers of the New World began to claim, occupy, and divide up parcels of land based on the European system of defining or describing land according to its relative position to well-known landmarks and by identifying the adjoining landowners. Although the large land settlement companies usually claimed land based on latitudinal boundaries, the precision needed to define smaller, individual holdings by astronomic position was not possible. It was much simpler, quicker, and more distinctive to choose natural boundaries to designate the limits of large tracts. Rivers, being the transportation arteries at the time, figured heavily in these early boundary definitions. Other natural features were also used and were usually chosen for their distinctive appearance or durability.

Of course, it was difficult to find rivers, streams, or rock formations in just the right locations to use as landmarks when the limits of a parcel of a particular size were being defined. This meant that artificial landmarks or monuments had to be set by the owners as a substitute for natural ones. Again, the limits of the parcel were defined by the actual location of particular corner landmarks or monuments.

In many cases of areas of long settlement, the construction of fences, hedgerows, or other obvious physical signs of the parcel limits made the task of marking the boundaries less difficult. The primary means of distinguishing one parcel from another became the "bounds" system. Land was held and worked by individuals on a regular basis. One need only name the individuals who owned, and usually lived on, the land surrounding a particular parcel to define where it was and what were its limits. This "bounds" system did not require that the size of the parcel be determined in order to define it.

In order to describe *roughly* the size of land parcels and assist in defining the location of that parcel, the concept of "metes" was used, along with the naming of natural landmarks, artificial monuments, and adjacent owners. The business of measuring between corners, outlined earlier, was taken on by anyone and everyone. The corners or limits of the land were physical marks on the ground. The "metes" were the measurements between those marks. Often, a landowner would simply pace off a section of land, set boundary stones, and sell the land so marked to another. The stones, neighboring landowners, and the paced distances would all be recorded in the sale, but the land would be occupied, cultivated, and possessed according to the location of the *corner monumentation*. This record of the distances (metes) and physical limits (bounds) of a land parcel constituted a "metes and bounds" description.

The metes and bounds description of a land parcel is, in essence, the words that draw a picture. It takes the form of an imaginary trip, leading the reader from a relatively well-known landmark to and around the parcel being defined. The naming of landmarks or monuments at each corner, along with the identification of each adjoining parcel, is an essential part of the description.

The metes and bounds description is so ingrained in the land title community and dovetails so well with the laws regulating the transfer of titles that, even in areas where more precise land identification systems are used, the metes and bounds description is often used to supplement land record system descriptions. A complete boundary description using the metes and bounds system will incorporate the following:

1. A commencing point that is well known, easily found, permanent, recoverable, recognizable, and preferably public in origin. The purpose of the commencing point is to clarify the location of the parcel in relationship to some universally recognized landmark.
2. A point-of-beginning that is a part of the property being described. The purpose of the point-of-beginning is to emphasize that the limits of the parcel itself are to follow in the dialogue. The point-of-beginning is used purely for descriptive purposes and is not the point where a Land Surveyor "begins" a survey.
3. A report of the physical objects (monuments) that mark the location of ends, and sometimes areas, along each line.
4. A report of the contiguous owners along each line or land record identification of the contiguous parcels (bounds).
5. A direction, usually a bearing, for each line. In some cases, the angle formed at a corner may be reported in lieu of a bearing. In the cases of curved or meandering boundaries, the appropriate words necessary to describe the configuration of the line are used.

6. A distance between each corner (metes).
7. The area of the parcel.[1]
8. Reference to the particular plat or map of survey that forms the basis for the description.[2]

Metes and bounds descriptions are, of necessity, redundant. A particular boundary will have several requirements placed on it. A boundary line will be reported as having a particular adjoiner, having certain monuments as its limits, having a certain length and direction, and as combining with all of the other boundaries to form an enclosed parcel of a particular area. It is not difficult to see that, given the inaccuracies of measurements, many of these elements might be contradictory.

The history of the development of the metes and bounds description shows that, for the most part, the physical limits of a parcel controlled possession and use of the land. Because of these factors, the practice, in most areas, has settled on a "hierarchy of calls" that rank the elements of a metes and bounds description. This ranking of calls is based on the rules of evidence and is commonly broadened to assist in interpretation of all forms of descriptions and boundary recovery.

The most common hierarchy of calls is as follows:

Natural monuments[3]
Artificial monuments[4]
Directions
Distances[5]
Areas

[1]The area is not a necessary part of a metes and bounds description.

[2]All metes and bounds descriptions must be based on a survey. The survey may have been crude, unplatted, and performed by the individuals involved in the sale, but, unless someone "measured" the distances and visited the bounds, a metes and bounds description is impossible.

[3]Natural monuments may consist of rivers, rock formations, trees, and other distinct features. Features made by humans, such as canals, levees, highways, or mounds, may be considered as natural monuments under certain conditions.

[4]Objects placed for the specific purpose of marking boundary corners, such as posts, concrete posts, iron rods, pipes, or other physical markers, constitute artificial monuments only when they are correctly set and undisturbed. Many Land Surveyors' markers represent locations that are not boundary controlled. These markers are not "artificial monuments" in the context of this listing.

[5]In Louisiana, the status of distances and directions is reversed. In some states, these items are combined.

Any element of a description of a parcel may be rejected or overruled, based on a review of the best evidence available. The courts have usually held that the most important and overriding factor in the interpretation of property descriptions is *the intent of the parties*.[6]

All of the words of a deed are to be considered so that evidence that best demonstrates the intention of the buyer and seller will prevail in most cases. With this in mind, the writer of a metes and bounds description should ensure that the *intention of the parties is clearly expressed*.

The significance of this ranking will be evident during the examination of the process of corner recovery. The charge that society gives to the Land Surveyor is to recover the boundaries where they exist on the ground. The wonderful precision of measurement and location that is possible today is of little use if an incorrect location for a boundary corner is used. A poor measurement to the correct corner is much superior to a precise measurement to a false corner. In real property boundaries, it is the *physical location of the corners that is important*.

During the early years of the settlement of the United States, when metes and bounds descriptions were the primary system of identifying and locating land parcels, the fact that every copy of a document had to be handwritten limited the use of survey plats to sketches and caused many to shorten descriptions to the point that the intentions of the parties became obscure. The dimensions of the parcels were often ignored or reduced to a report of adjoiners only.

Often, the dimensions reported in these early descriptions were the results of estimations by the landowners, not Land Surveyors. Measurements by amateurs, and indeed some Land Surveyors, most commonly report distances between monuments as being greater than the actual distance. Rough terrain, poor chaining techniques, meandering routes, and other error-developing factors more often misled all into believing a greater distance was covered than was actually traversed. Because vast areas of land were rapidly being settled, the shortage of skilled Land Surveyors forced many to depend on themselves to measure their land. Even today, in order to save a few dollars, many land transfers take place without a land boundary survey to verify the dimensions of a parcel.

The situation of possessing according to physical marks should be distinguished from the case of a transfer of property where relying on specific dimensions is the intention of the parties. If a sale is not followed by possession and it was the clear intent of the parties to transfer a land parcel of specific size and shape, then any blunders

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[6]C. M. Brown, W. G. Robillard, D. A. Wilson, *Evidence and Procedures for Boundary Location,* 5th ed. Hoboken, NJ: John Wiley & Sons, 2006.

in marking the limits of such a parcel can be corrected at any time. The intent to transfer a specific-sized parcel can occur only in cases of resubdivision. Original private claims and USPLS parcels cannot fall into this category because *possession* was required in the first case and the *corners set by the government surveyor* controlled in the latter.

7.1.1. Reading a Metes and Bounds Description

The most difficult part of writing a metes and bounds description is deciding the degree of detail required to convey the intentions of the parties. The natural instincts are to limit the verbiage as much as possible so that the resulting descriptions are not overly "wordy." Unfortunately, this trend has led to many misinterpretations in the past. Instead of rehashing the general rules, perhaps a review of some typical parcels and how their metes and bounds descriptions might be created would better clarify the need for specificity.

In Figure 7.1, the iron post shown is reported by the Land Surveyor as monumenting the intersection of the line between the parcels known as the "Brownell" estate and the "Willis" estate with the northernmost right-of-way line of "Patterson Highway." Each of the corners of the "Johnston" property is monumented by six-inch square concrete posts. The Willis estate, in this example, is the parent tract from which the Johnston property was formed. It is the intention of the parties that the parcel sold be 200 feet wide, 500 feet deep, and commence 388 feet from the western boundary of the Willis estate, as measured along the highway, and that the sidelines of the parcel be parallel with the western boundary of the parent estate.

The plat of the survey by Jackson clearly reflects these intentions and provides some additional information. The large iron post is a well-known (in 1923) and accepted feature that qualifies as an artificial monument. The six-inch square concrete posts are simply survey markers set by Jackson. These may mature into artificial monuments, provided sufficient acts of possession and reliance on these posts take place. There is a discrepancy on the survey plat in the form of an incorrectly computed area. Assuming that all of the other dimensions are correct, the area should be 2.21 acres (rounded off to the nearest one-hundredth of an acre).

A typical metes and bounds description of the period might read:

> . . . a 2.3 acre parcel of land measuring 200 feet wide by 500 feet deep between equal and parallel lines and beginning 388 feet from the western boundary of

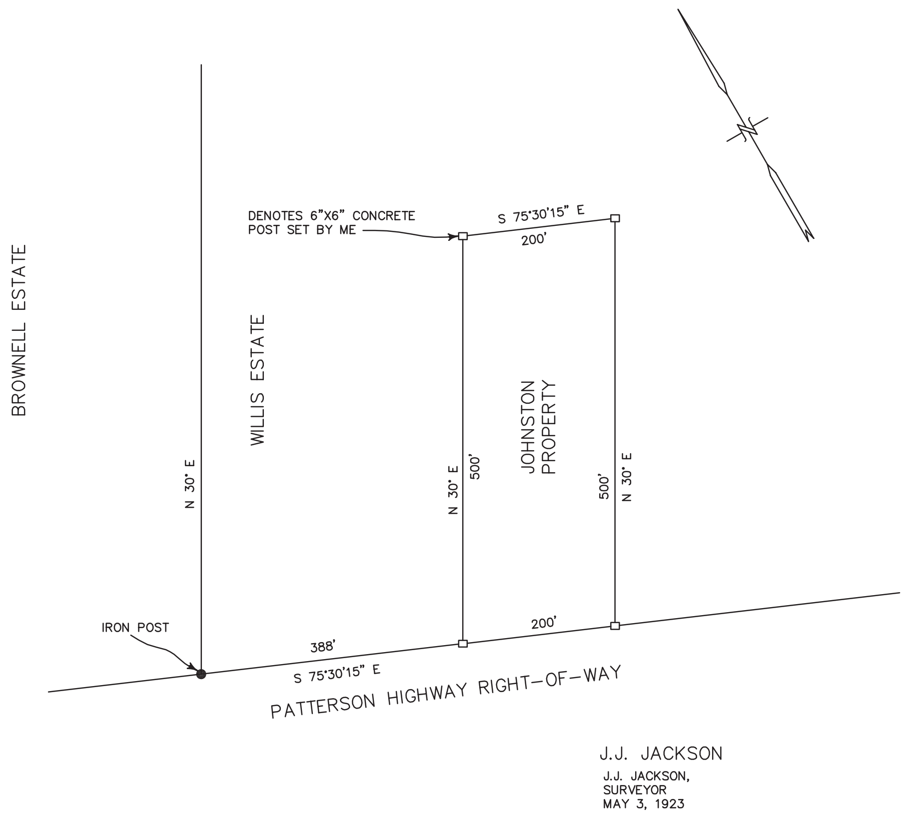

FIGURE 7.1

> the Willis Estate, bounded in the front by the Patterson Highway and on the sides as well as in the rear by the property of the seller. . . .

Note the lack of reference to the survey plat by Jackson. If such a reference had been made, then the several discrepancies between the description and the intention of the parties might be clarified. Even if such a reference were made, there would always exist the possibility that the survey plat might not survive. For this reason, metes and bounds descriptions should be written as if all other documents reflecting the intentions of the parties were going to be destroyed.

Figure 7.2 shows one interpretation of the description superimposed on the original survey plat. The scale is distorted to emphasize the discrepancies.

The description does not reflect the intentions of the parties to the sale. Later surveys that recover the concrete posts set by Jackson will

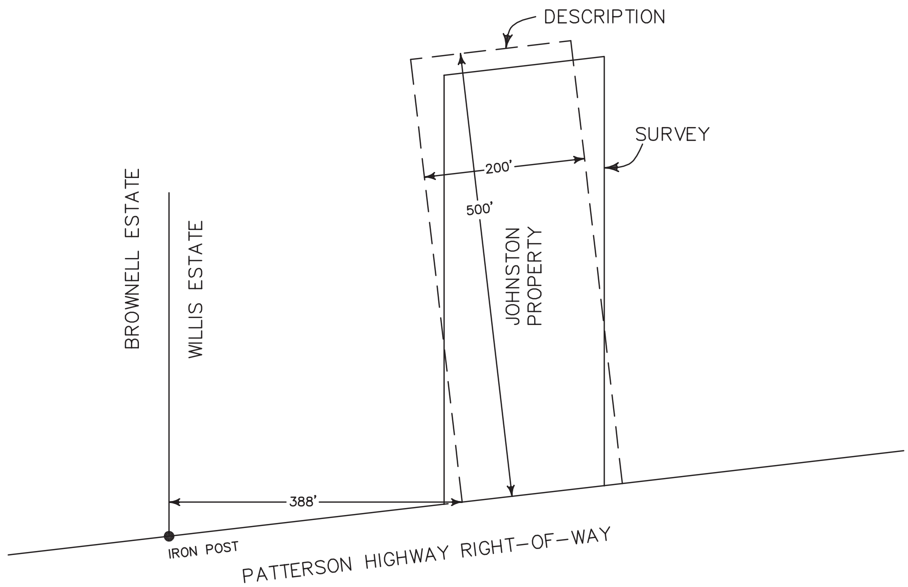

FIGURE 7.2

require additional evidence and be accompanied by sufficient possessive acts before it can be stated with confidence that they do indeed represent the intended limits of the Johnston property. Even if the survey plat by Jackson were to surface, it might be argued that it was not relevant because it was not part of the written instruments included in the transaction. Now consider the following description:

> . . . commencing at the large iron post[7] found at the intersection of the boundary line between the Brownell Estate and the Willis Estate and the northernmost right-of-way line of Patterson Highway[8]; thence, in an easterly direction[9] along said northernmost right-of-way line of Patterson Highway,[10] South 75 degrees

[7]Reference to the "iron post" fixes the commencement point to a recoverable terrain feature. If, at some later date, the location of the boundary between the Brownell and Willis estates were to become unclear, the location of the Johnston property would not be cast in doubt.

[8]The reference to the intersection of the boundary line and the right-of-way line of the highway is used not only to document the location of the iron post, lest it be disturbed, but also to emphasize that the right-of-way for Patterson Highway is relevant to the measurements.

[9]The words "in an easterly direction" are used to assist the reader in interpreting whether the south–east or the north–west version of the bearing that follows is appropriate.

[10]This removes any doubt about the line of measurement of the 388 feet. It is clear that it was not the intention of the parties that the 388 feet be measured at right angles to the boundary line.

> 30 minutes 15 seconds East, a distance of[11] 388 feet to the Point-of-Beginning[12]; thence, in a northerly direction parallel with the boundary line between the Brownell Estate and the Willis Estate,[13] North 30 degrees East, a distance of 500 feet; thence, in an easterly direction parallel with the northernmost right-of-way line of Patterson Highway, South 75 degrees 30 minutes 15 seconds East, a distance of 200 feet; thence, in a southerly direction parallel with the boundary line between the Brownell Estate and the Willis Estate, South 30 degrees West,[14] a distance of 500 feet to the northernmost right-of-way line of Patterson Highway; thence, in a westerly direction along said northernmost right-of-way line of Patterson Highway,[15] North 75 degrees 30 minutes 15 seconds East, a distance of 200 feet to the Point-of-Beginning, encompassing an area of 2.3 acres[16] and all as more fully described on a plat of survey by J. J. Jackson, Surveyor dated May 3, 1923[17] . . .

This description is somewhat longer than the first example, but it presents a much more accurate picture of the transaction. The inclusion of the survey plat as part of the description also gives a clue to the source of the information given in the description.

Figure 7.3 represents a survey plat of the same Johnston property 55 years later. The changes that time has wrought are not as great as might have been expected. Two of the original concrete posts are still standing and, from all indications, were not disturbed during all that time. It is known that Abraham Johnston built the house in 1926 and has lived there ever since. The acceptance and use of these concrete posts by the possessor of the parcel has converted them from

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[11]The use of "a distance of" assists the reader in distinguishing distances along the described boundary line and other dimensions that maybe necessary, such as a radius for a curve, and so on.

[12]If one were to insert the phrase "to a 6-inch square concrete post" here, then the distance "388 feet" might be interpreted as an estimation and the concrete post might be considered an artificial monument, without any acts of possession. Blunders by Jackson in setting the posts may not be correctable. Adequate possession with reliance on the post would make this a moot point.

[13]By calling for the sidelines to be parallel to the western boundary, any measurement blunder by Jackson should not alter the location of the line.

[14]Notice that the survey plat indicates the direction to be "North 30 degrees East." The survey plat is a two-dimensional drawing; therefore, "North 30 degrees East" and "South 30 degrees West" define the same line.

[15]This leaves no doubt that frontage on Patterson Highway is intended for this parcel.

[16]The incorrect area is repeated in the description but is of no consequence in the absence of any evidence that it was the controlling factor in the intention of the vendor or vendee.

[17]The reference to the survey plat in the description has the effect of including the plat as an integral part of the description. Discrepancies between the written description and the figures on the plat are normally resolved in favor of the plat, unless clear and convincing evidence to the contrary is discovered.

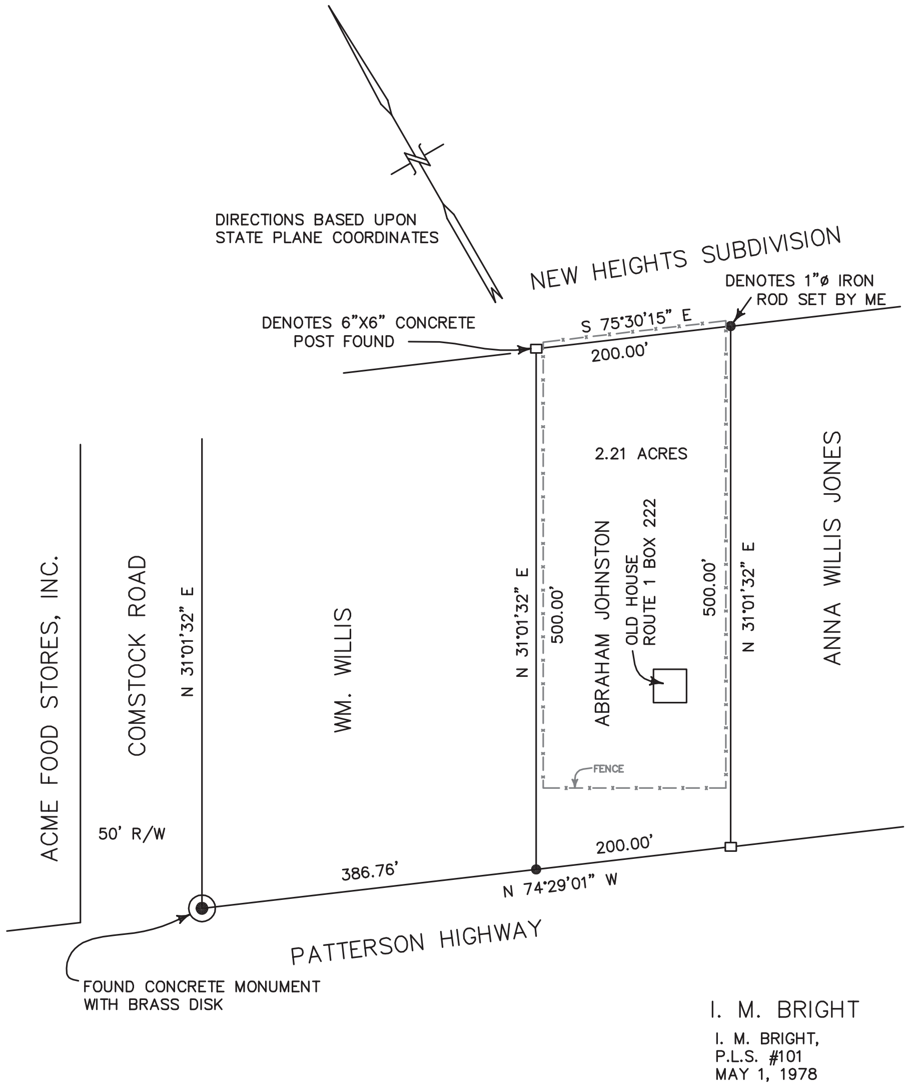


FIGURE 7.3

mere survey markers, attempting to demonstrate the intent of the parties, into artificial monuments that clearly define the limits of the parcel.

The easternmost line of Comstock Road is believed to be the original line between the Brownell and Willis estates. So many changes have occurred that a new metes and bounds description is required in order for the property to be recognized. The application of the hierarchy of calls, as well as the professional judgment of Bright, will be noted during the development of the updated metes and bounds description.

> . . . commencing at a brass disk set in concrete found at the intersection of the easternmost right-of-way line of Comstock Road and the northernmost right-of-way line of Patterson Highway[18]; thence, in an easterly direction along said northernmost right-of-way line of Patterson Highway, South 74 degrees 29 minutes 01 seconds East,[19] a distance of 386.76 feet to a 1 inch diameter iron rod on the easternmost boundary line of the property of William Willis and the Point-of-Beginning[20]; thence, in a northerly direction along said easternmost boundary line of the property of William Willis,[21] North 31 degrees 01 minutes 32 seconds East, a distance of 500.00 feet to a 6 inch square concrete post on the southernmost boundary line of New Heights Subdivision[22]; thence, in an easterly direction along said southernmost boundary line of New Heights Subdivision, South 74 degrees 29 minutes 01 seconds East a distance of 200.00 feet to a 1 inch diameter iron rod on the westernmost boundary line of the property of Anna Willis Jones; thence, in a southerly direction along said westernmost boundary of the property of Anna Willis Jones, South 31 degrees 01 minutes 32 seconds West a distance of 500.00 feet to a 6 inch square concrete post on the northernmost right-of-way line of Patterson Highway; thence, in a westerly direction along said northernmost right-of-way line of Patterson Highway, North 74 degrees 29 minutes 01 seconds West, a distance of 200.00 feet to the Point-of-Beginning, encompassing an area of 2.21 acres and all as more fully described on a plat of survey by I. M. Bright, P.L.S. dated May 1, 1978 . . .

[18]This commencement point may or may not be in the identical location as the large iron post found in the 1923 description. The differences in the commencement distance that follows may be the result of a slight change in the accepted position for the line between the original estates or may indicate a measurement discrepancy between Bright and Jackson.

[19]The route of the description is in an easterly direction. Therefore, the bearing must be south–east, not north–west. The difference in magnitudes is not significant. The modern survey is oriented to state plane directions; the 1923 survey does not report a bearing base.

[20]The call is to the iron rod in this case, because nearby original concrete posts enabled Bright to recover and remonument the southwest and northeast corners of the tract. The original concrete posts have clearly become artificial monuments, marking with certainty the limits of the Johnston property.

[21]There is no longer the need to specify the line as parallel to the original boundary between the Brownell and Willis estates.

[22]The fact that the distances are now reported to the one-hundredth of a foot is an indication of the precision of the measurements. The size of the end monuments (6 inches $\times$ 6 inches and 1 inch o.d.) are such that a variation of 0.10 feet or so ought to be expected. Bright chose to report the same metes as Jackson.

In the day of hand-copied records and manual typewriters, the preceding description would have been condemned as much too verbose. In the modern world of copying machines and word processors, there is no need to sacrifice clarity of intent by reducing the length of a metes and bounds description. Some may still insist that the exact same idea can be expressed in fewer words. If we trim any mention of "New Heights Subdivision," then the description would read as follows:

> . . . commencing at a brass disk set in concrete found at the intersection of the easternmost right-of-way line of Comstock Road and the northernmost right-of-way line of Patterson Highway; thence, in an easterly direction along said northernmost right-of-way line of Patterson Highway, South 74 degrees 29 minutes 01 seconds East, a distance of 386.76 feet to a 1 inch diameter iron rod on the easternmost boundary line of the property of William Willis and the Point-of-Beginning; thence, in a northerly direction along said easternmost boundary line of the property of William Willis, North 31 degrees 01 minutes 32 seconds East, a distance of 500.00 feet to a 6 inch square concrete post; thence, in an easterly direction, South 74 degrees 29 minutes 01 seconds East a distance of 200.00 feet to a 1 inch diameter iron rod on the westernmost boundary line of the property of Anna Willis Jones; thence, in a southerly direction along said westernmost boundary of the property of Anna Willis Jones, South 31 degrees 01 minutes 32 seconds West a distance of 500.00 feet to a 6 inch square concrete post on the northernmost right-of-way line of Patterson Highway; thence, in a westerly direction along said northernmost right-of-way line of Patterson Highway, North 74 degrees 29 minutes 01 seconds West, a distance of 200.00 feet to the Point-of-Beginning, encompassing an area of 2.21 acres and all as more fully described on a plat of survey by I. I M. Bright, P.L.S. dated May 1, 1978 . . .

At first glance, there doesn't appear to be any difference between the two descriptions. Let us assume that the second version is used and that the northernmost concrete post, as well as the iron rod, are destroyed. Later, when New Heights subdivision's southern boundary is monumented and found to be 501 feet from Patterson Highway, who owns the strip between the 500-foot rear line of the Johnston property and New Heights subdivision? The boundary action needed to settle this aggravating, petty discrepancy might have been avoided by the use of a complete, albeit wordy, metes and bounds description.

7.2. U.S. PUBLIC LAND SYSTEM (USPLS)

The great American philosopher, Will Rogers, once said:

> "The trouble ain't so much the things we don't know—it's the things we do know that just ain't so."

I know of no instance where this thought is more applicable than in USPLS states. A close examination of the origin and history of the USPLS will lead us to a better appreciation of the ingenuity—and pitfalls—associated with this system.

At the end of the Revolutionary War, the United States was a new nation without a firm revenue base. Taxes were unthinkable; yet it takes money to operate a federal government. The one thing that the fledgling country did have was land. From the original state cessions in 1781 to the purchase of Alaska in 1867, approximately 1,807,682,000 acres of land were acquired by the federal government, and the faster this land could be turned into hard cash, the better. The prime, yet unwritten, directive to the committee that created the Ordinance of 1785 was to divide public lands into marketable portions. In order to accomplish this, the following things, listed by priority, were necessary.

1. The parcels had to marked on the ground so that the new landowners could take possession of their land.
2. The parcels created had to be uniquely identifiable.
3. The system of identification had to be one that required little formal education to use, if not understand.
4. Further division of the created parcels had to be simple, universal, systematic, and based on the location of the monumented corners, and could not require additional survey work by the government surveyor.
5. The time and paperwork required to create and subdivide each parcel had to be kept to a minimum.
6. The system could not depend on prior knowledge of the terrain in order to implement it.
7. The quality or arability of the land had to be reported to determine relative value.
8. The dimensions of the sides of the parcel and other measurements had to be reported to *facilitate the recovery of the corner markers*, as well as estimates of acreage.

Notice the priority given to measuring the dimensions of the newly created parcels. Land lines are defined by the corners *set by the government surveyor*, not by the reported dimensions or directions. The USPLS fulfilled these requirements completely and in the required order of priority. It is important to keep this order of priority in mind when dealing with USPLS parcels.

As the USPLS was perfected over the years, slight changes in the techniques, numbering order, monumentation, and other minor alterations took place. The 20 states that do not operate under the USPLS are Connecticut, Delaware, Georgia, Hawaii, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Vermont, Virginia, and West Virginia. The other 30 states are USPLS states, and the exact version of division used in each area vary according to the instructions in force, the government surveyor, the terrain, local customs, and other factors.

7.2.1. Initial Point

As so often occurs in surveying, the theory is simple, but the application is complex. The theory of the USPLS was based on a rectangular division of land along the cardinal directions. The first step in the division of an area of land, such as a state, under the USPLS, was the establishment of the "initial point" for that division. Although some attempt was made to locate initial points at a specific latitude (a list of initial points was made, reporting both latitude and longitude of the various initial points[23]), the initial point was the actual location, on the ground, as monumented by the government surveyor. The reported position existed only to assist in the recovery of the true location.

7.2.2. Principal Meridian

Having chosen and monumented the initial point, the government surveyor established the "principal meridian" by traversing north and south from the initial point. Depending on the instructions at the time, a post or other monument was set at least every six miles or as often as every half mile. The principal meridians were run with particular care, and every attempt was made to run the line "true" north, resulting in an approximation of astronomic north being marked on the ground.

[23] J. G. McEntyre, *Land Survey Systems*. New York: John Wiley & Sons, 1978.

7.2.3. Baseline

Lines were also laid out east and west from the initial point and monumented with the same frequency as the principal meridian. This "curved" line is called the "baseline" and is actually a series of short chords between the monuments set by the government surveyor. As with the principal meridian, every attempt was made to follow the "true" or cardinal direction, resulting in an approximation of the astronomic latitude of the initial point.

Figure 7.4 demonstrates what should have been the result of the establishment of a typical initial point, principal meridian, and baseline.

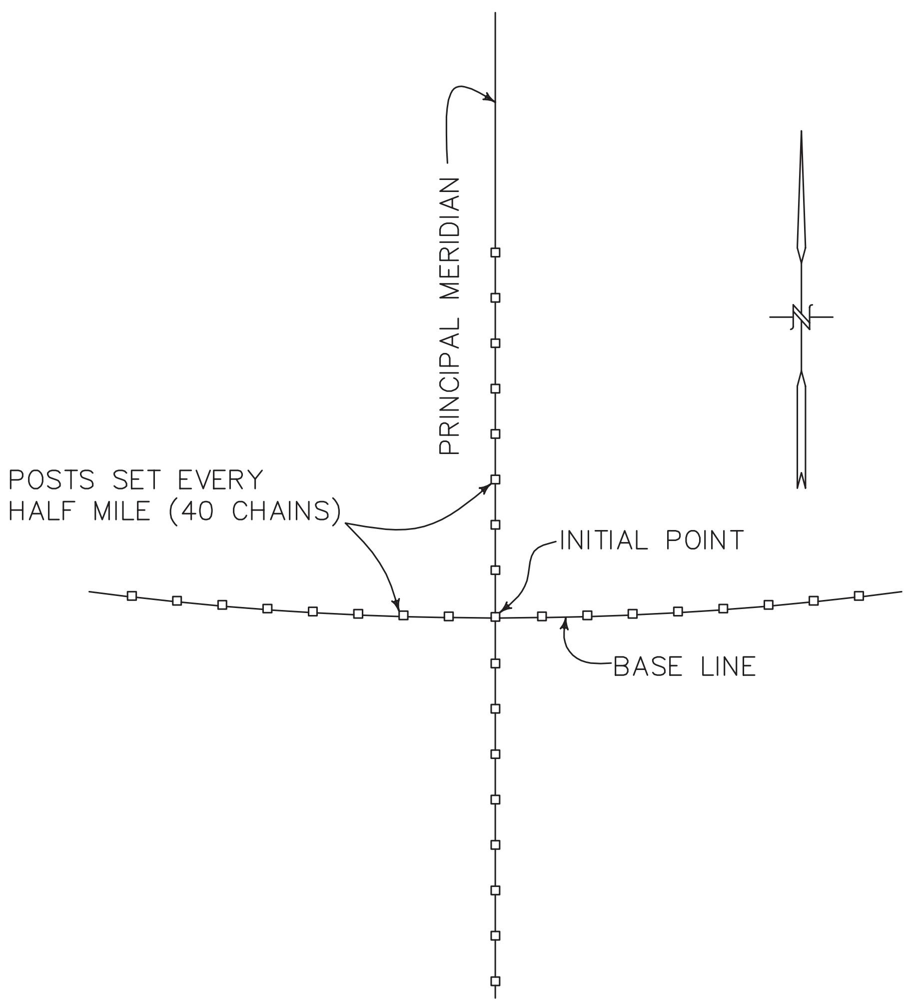


FIGURE 7.4

Additional or "correction" east–west lines may have been monumented at regular intervals along the principal meridian with the same care as the baseline so that a correction could be made for the convergence of the meridians. It was well known by the designers that a rigid rectangular division of land based on the cardinal directions was impossible, but the inaccuracies of measurement, the scientific unsophistication of the ultimate user of the system, the need for haste, and the need for a simple method of record keeping outweighed the requirements of accuracy.

7.2.4. Township and Range Lines

After the establishment of the principal meridian and the base line, additional east–west lines were monumented at 6-mile intervals along the principal meridian. These are known as "township" lines. Additional north–south lines were monumented along the base line, and later along correction lines, at 6-mile intervals.[24] These are known as "range lines." The theoretical result of these steps is shown in Figure 7.5.

Each east–west row of "6-mile squares" is identified by numbering its position north or south of the base line. Each north–south column of "squares" is identified by its position east or west of the principal meridian. Thus, every square, called a "township," is uniquely identifiable by a simple report of its township number and range number.

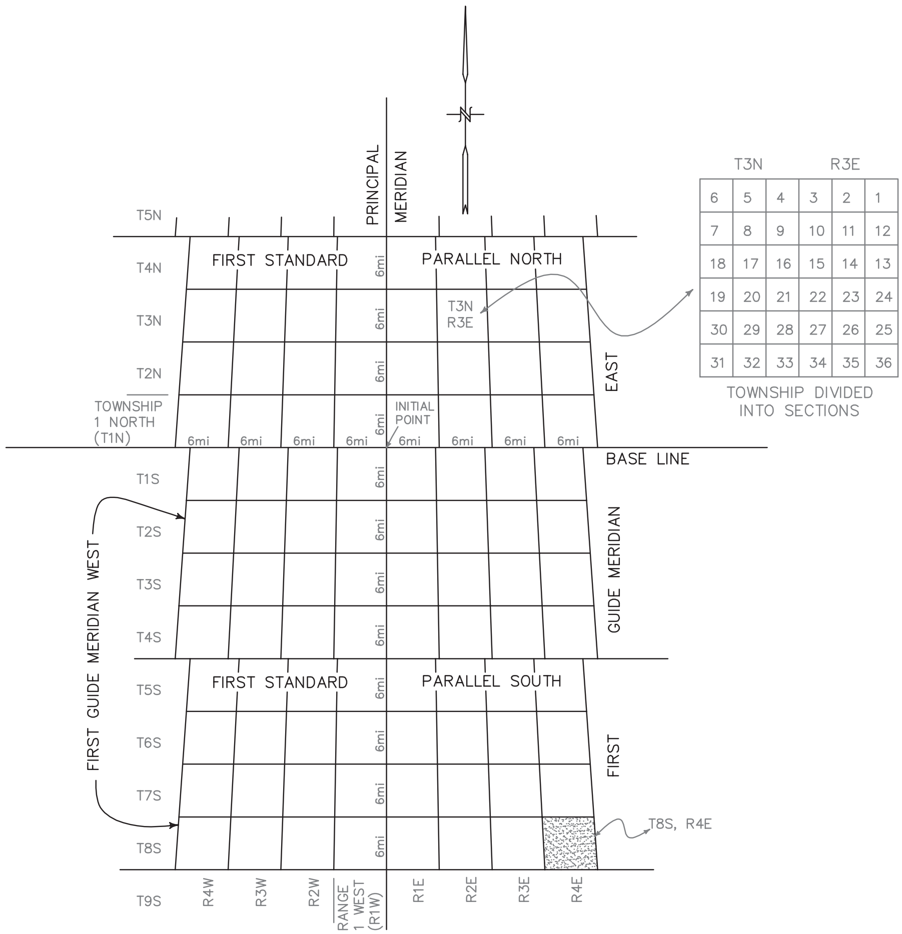
Notice that township 8 south, range 4 east has been highlighted in Figure 7.5. This is abbreviated to "T8S, R4E."

The township and range lines were not run with quite the same degree of care as were the principal meridian and the base line. Of course, none of the townships were exact squares measuring six miles on a side. This fact is not important to the division and inventory of the land, and, although not forgotten, it was set aside by the planners of the USPLS because it was considered relatively unimportant.

7.2.5. Ideal Township

Further division of each township was accomplished by running lines that were, more or less, north–south and east–west at one-mile intervals and monumented every half mile. Each resulting "square mile" is called

[24]The interval between correction lines varied from every fourth to every sixth township line, depending on the instructions in force at the time.



6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

FIGURE 7.5

a "section" and identified by a number. The work of monumentation was typically begun at the southeast corner of each township and progressed to the north and west until the entire township was monumented. The discrepancies that resulted from the closure of the meridians, errors of measurement, and undiscovered blunders were accounted for by allowing the western tier and northern row of sections to deviate from the "square mile" template.

All other sections were *reported* as squares measuring one mile to a side. Of all the over 2 million sections monumented by the Government Land Office (GLO), it is safe to say that *none* is a square measuring

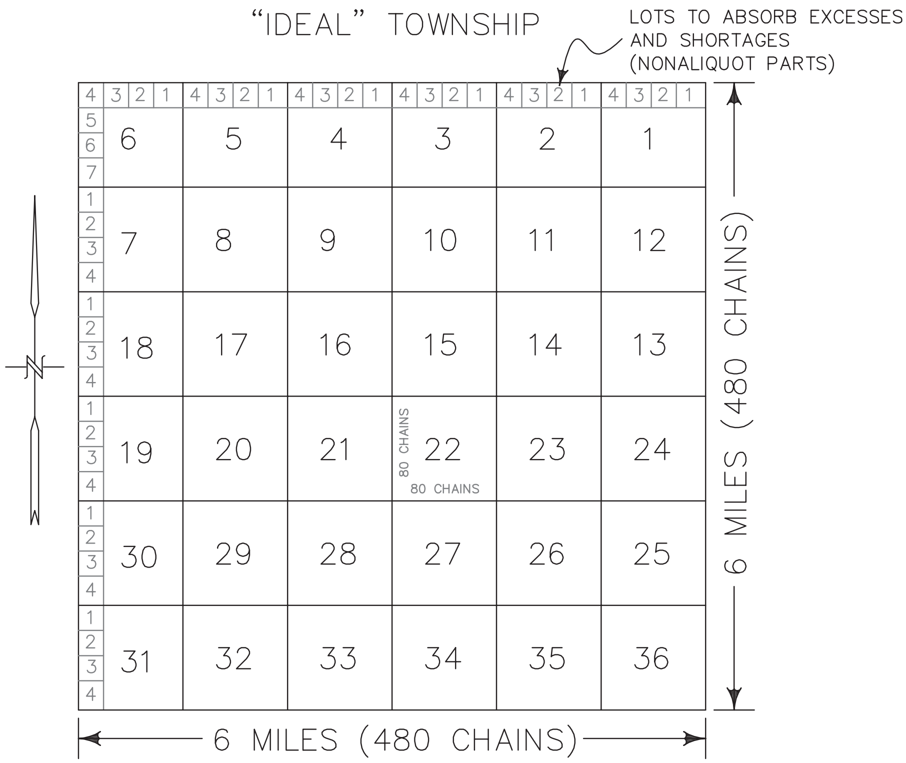


FIGURE 7.6

one mile to a side and few are even close, especially when the precision of modern surveys are considered. Still, the "ideal section" must be discussed in order to explain the USPLS. Figure 7.6 is that of the "ideal township," divided into "ideal sections."

7.2.6. Ideal Section

The division of the "ideal section" into its aliquot parts is something that has been widely sketched and described as *if the dimensions of the sides* were an important part of the process. This is not the case. The beauty of the USPLS is the very fact that it is *independent* of dimensions. It is a system that depends entirely on the actual locations of the corners set by the government surveyor, and *nothing else*.

Figure 7.7 shows the division of a section and how each parcel is identified. The dimensions are not shown, because they are *not essential* to the process and tend to only mislead the novice into believing that

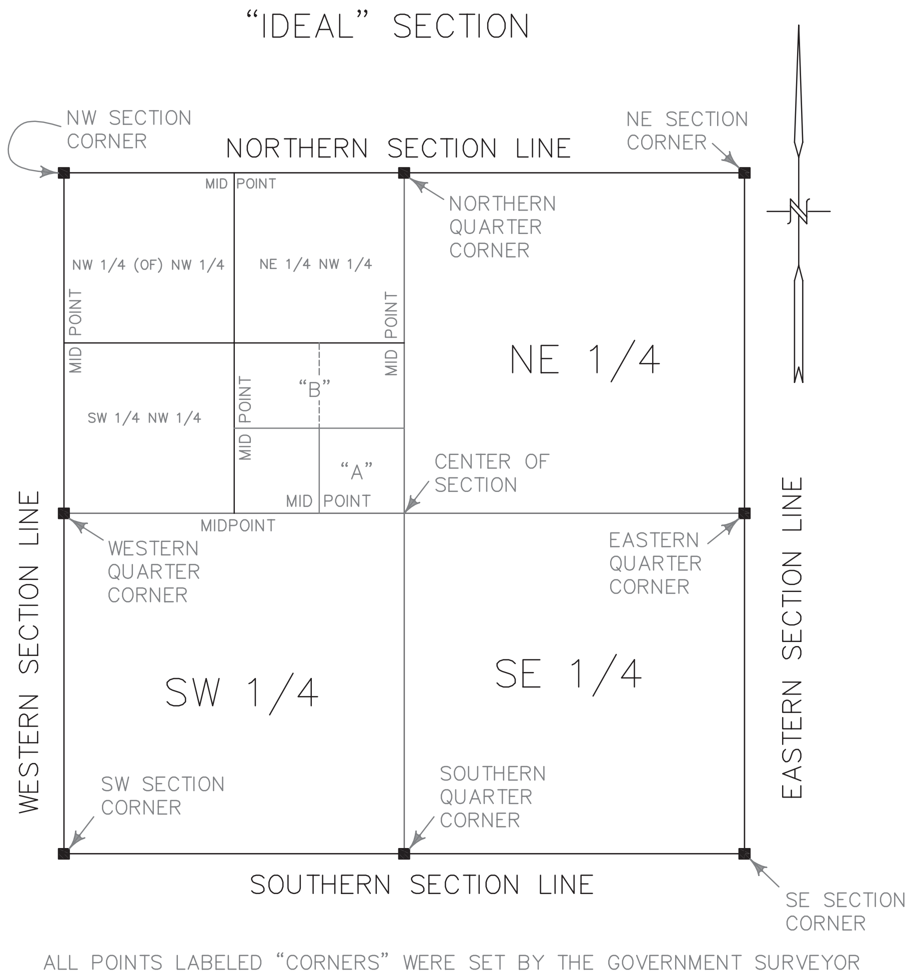


FIGURE 7.7

sections and their aliquot parts should measure the same as the example in the explanation.

The monuments set by the government surveyor at what was typically reported as 1-mile intervals (80 chains) are the section comers. Often monuments were also set by the government surveyor at, reportedly, half-mile intervals (40 chains). These are called "quarter corners." The linchpin of the USPLS is the actual location, on the ground, of the monuments set by the government surveyor. The reported directions and distances can be, and usually are, incorrect or, at best, imprecise. The physical spot on the ground monumented by the government surveyor is, and can only be, in one place, nowhere else. That location can be lost, obscured, misreported, and confused but *never moved*. No matter how imprecise the measurements or how gross the blunders are that may have occurred, the corner monumented can mark only one land point on the earth, and that land point is exactly where it is. Because the actual location of the monuments marking the corners is so vital, extraordinary emphasis must be placed on the recovery of these locations.

Straight land lines between opposite quarter corners divide the section into a southeast quarter (SE$^1/_4$), a northeast quarter (NE$^1/_4$), a southwest quarter (SW$^1/_4$), and a northwest quarter (NW$^1/_4$). The intersection of these lines is a land point and is called the "center of the section." Further division is accomplished by connecting straight lines between the midpoints of opposing sides of the larger tract. The description of the resulting parcel is identified by listing the divisions made in the reverse order in which they were made. Tract "A" in Figure 7.7 is the southeast quarter of the southeast quarter of the northwest quarter of the section. Tract "B" is the north half of the southeast quarter of the northwest quarter of the section.

If Figure 7.7 was that of section 26, in the fourth township south of the base line and the fifth range west of the sixth principal meridian, then tract "A" could be uniquely identified by the single line "SE$^1/_4$ SE$^1/_4$ NW$^1/_4$ Sec. 26, T.4S., R.5W., 6th P.M." Tract "B" would be abbreviated as "N$^1/_2$ SE$^1/_4$ NW$^1/_4$ Sec. 26, T.4S., R.5W., 6th P.M." Note the lack of commas in the list up to the section number. If a comma were inserted in the description of "B," for example, the result might be "N$^1/_2$, SE$^1/_4$ NW$^1/_4$ Sec. 26, T.4S., R.5W., 6th P.M." This could be interpreted as calling for the north half *and* the southeast quarter of the northwest quarter of the section!

The dimensions of tract "A" or "B" in the example are not known and are not important in the description. What is known about the dimensions of these parcels is that, if section 26 were an "ideal" section, with each side measuring 80 chains, then tract "A" would be a square measuring 10 chains on a side and encompassing 10 acres. Tract "B" would be a rectangle measuring 10 chains on the east and west and 20 chains on the north and south and encompassing 20 acres.

Of course, section 26 is not an "ideal" section; therefore, tract "A" will not be exactly 10 acres, nor will tract "B" be exactly 20 acres. A recovery and careful survey of the corners set by the government surveyor is required before a more precise knowledge of the dimensions of these parcels is possible.

7.2.7. Irregular Sections

The pattern of sections, and even townships, had to be interrupted because of several factors, such as existing private claims, large rivers, lakes, state boundaries, national boundaries, the sea, and other irregularities both natural and human made. This resulted in fractional sections, where the reported configuration deviated from the typical pattern. Aliquot division is still possible in these "irregular" sections by the application of certain rules design to isolate the irregularity.

7.2.7.1. Meander Lines Rivers, lakes, the shore of the sea, and other natural barriers that arose in the course of the monumentation of the section lines were accounted for by the "meander line." Figure 7.8 illustrates the application of the meander line along a navigable river. The limit of private ownership along a navigable river is defined by the waterway. It is not practical to measure each minute and sinuous turn of the waterway; therefore, a method that approximates the waterway is used.

In the example, the government surveyor encountered the river while running west along the line between sections 5 and 8. A meander comer was established on this line *at a convenient point* on or near the bank of the river. Additional meander points were established at points along the river, and the directions and distances between these points were measured so that the approximate shape of the bank of the river could be plotted. This resulted in the line labeled as the "meander line." All distances and directions are to the meander points, but the private ownership extends beyond the meander line to the waterway.

Each state has differing laws that define the limit of private ownership along navigable rivers, navigable lakes, the sea, non-navigable lakes, rivers, and streams. These boundaries are known collectively as "riparian boundaries."[25]

Although a general knowledge of the rules of the establishment and division of USPLS lands is important, each section was separately surveyed, monumented, and sold. Because of this, each section is unique in some way. The recovery of the corner monuments and knowledge of the boundaries of any section or its aliquot parts requires special knowledge of that particular section.

[25] Additional rules and definitions dealing with irregular sections and the aliquot division of USPLS sections constitute a book in itself. The reader desiring greater detail is referred to John G. McEntyre, *Land Survey Systems*. New York: John Wiley & Sons, 1978.

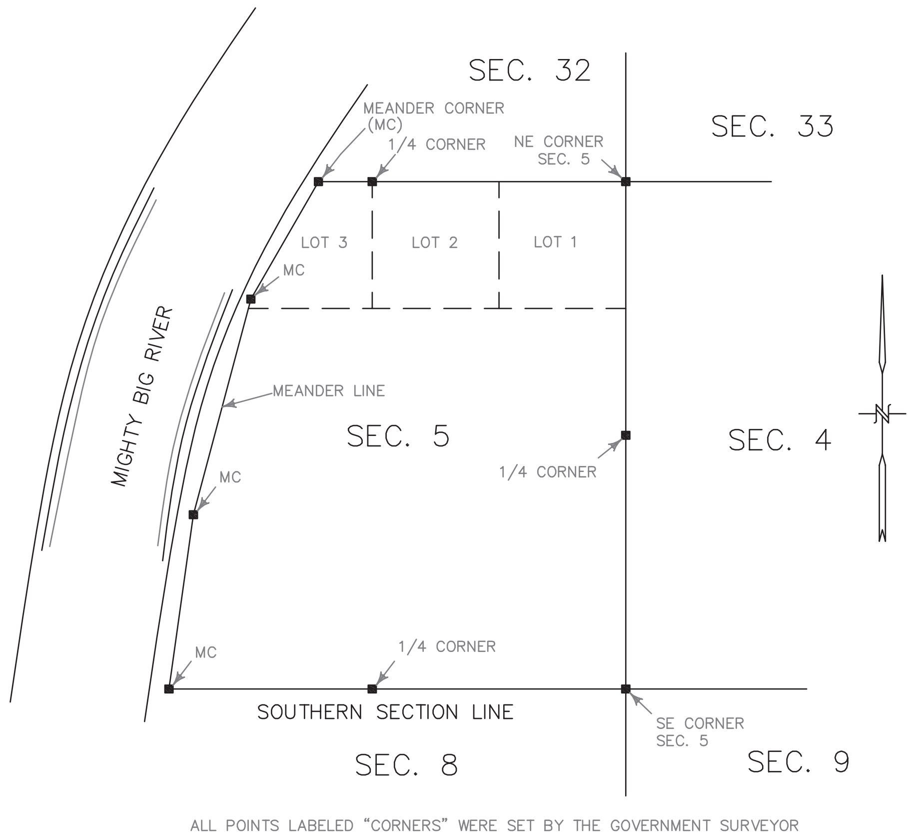


FIGURE 7.8

7.2.8. USPLS General Instructions

Depending on the year that the work was done, each government deputy surveyor was issued a set of general instructions. These instructions directed the details of measurement, monumentation, observations to be recorded, and method of division, among other things. Subsequent instructions might alter or expand upon previous ones. The instruction told the deputy surveyor how he *should* conduct the surveys; how the deputy surveyor actually performed the surveys is another matter.

7.2.9. Government Surveyor's Original Notes

Each government surveyor kept a record of the distances, directions, observations, monumentation, and other pertinent data in what is called the "surveyor's notes." Typically, these notes were not written as work was progressing but were transcribed from rough notes, usually kept on a slate, at the end of each line. The notes were the best record of what was done, how it was done, the order in which it was done, what was measured, what was encountered along the way, and how monumentation was accomplished.

These notes were used to create the township plats that mapped each township, showing the sections and/or lots that were to be sold to private owners. The government surveyor's notes and the township plat could only reflect the directions and dimensions reported at the time of the original survey. The actual configuration of any township, section, or lot was dictated by the location of the corners, not the reported dimensions.

This significant difference is best explained by an example. In Figure 7.9, the solid lines represent the reported route of the government surveyor and the reported location of the monuments set by the government surveyor. The small circles represent the actual location of the monuments. The dashed lines represent the actual section lines.

The dramatic differences between the reported and actual locations of the section corners in Figure 7.9 are not exaggerations. The

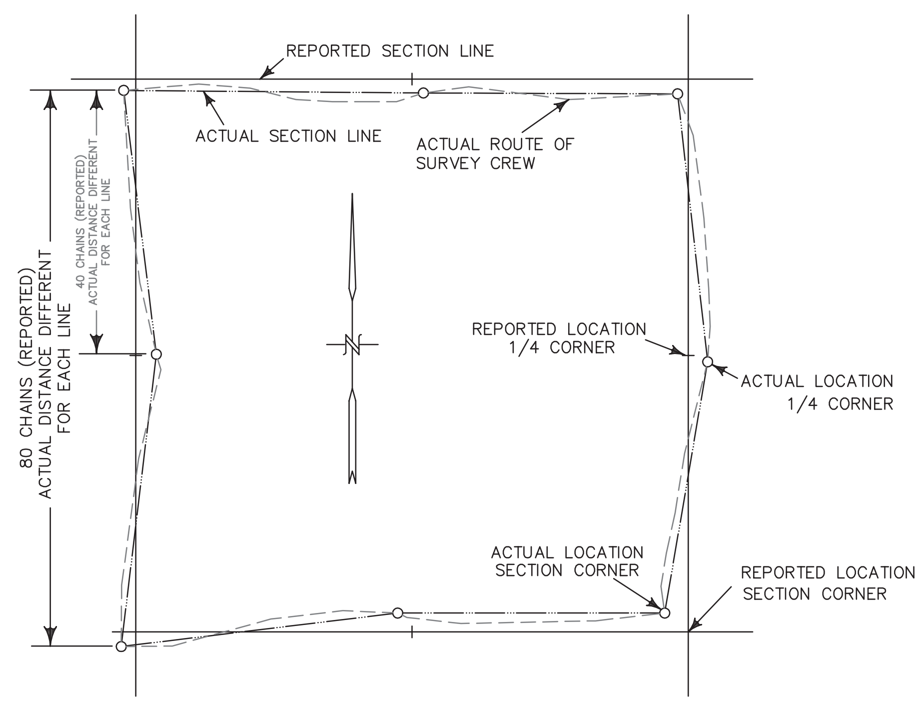


FIGURE 7.9

discrepancies between the reported and actual dimensions in this example, and greater, were common, especially in those states of early surveys. The division of the section, being dependent on section corner and quarter corner location, is accomplished in spite of the inaccuracies of the original reports of direction and distance. As a rule, *all* four quarter corners and at least one section corner *must* be recovered before any aliquot part of a section can be made.

For example, Figure 7.10 highlights the SE$^1/_4$ SE$^1/_4$ SE$^1/_4$ SE$^1/_4$ of the section. If the original survey information were relied upon, one might believe that this parcel formed a square 330 feet (5 chains) on a side and encompassed 2.5 acres. An improperly prepared metes and bounds supplemental description of this parcel might read, in part, "... commencing and Point-of-Beginning at the southeast Section corner; thence, West 330 feet; thence, North 330 feet; thence, East 330 feet; thence, South 330 feet to the Point-of-Beginning, encompassing an area of 2.5 acres. ..."

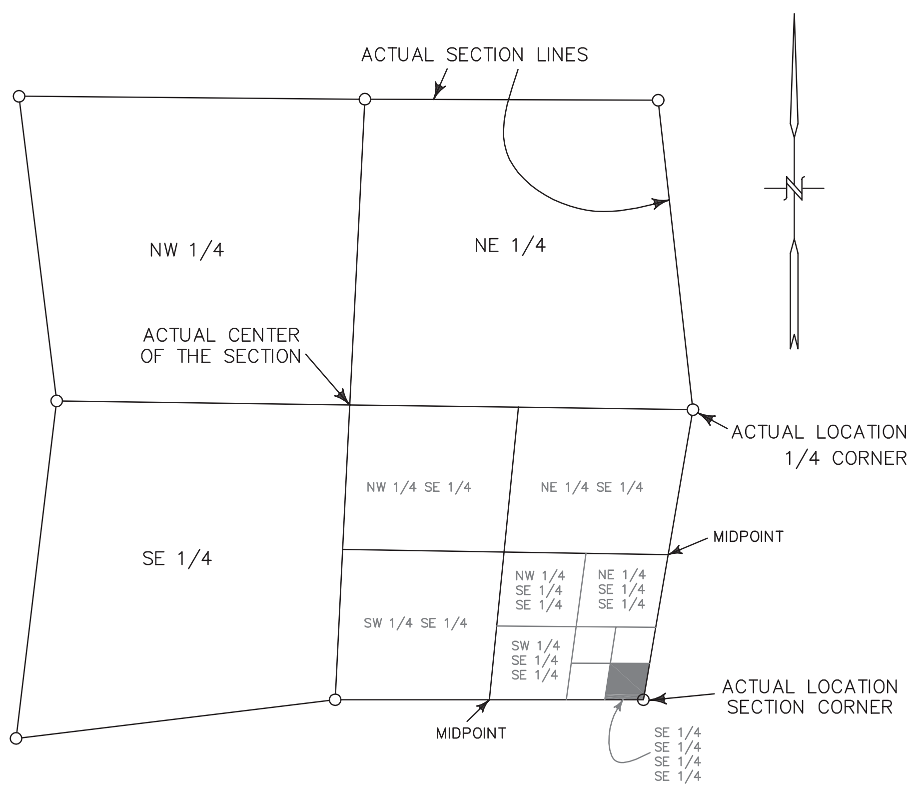


FIGURE 7.10

The novice might argue that one need only recover the southeast section corner, and, by measuring west, north, east, and south the 330 feet called for, this parcel could be monumented. This is simple but quite incorrect, as the very large discrepancies in Figure 7.11 clearly demonstrate.

In order for the described SE$^1/_4$ SE$^1/_4$ SE$^1/_4$ SE$^1/_2$ of the section to be monumented, all four quarter corners must be recovered, as well as the southeast section corner.

A "straight line" must be run between opposite quarter corners to establish the center of the section. The midpoint of each of the four sides of the resulting southeast quarter must then be set and a "straight line" run between opposite midpoints to establish the center of the southeast quarter.

The midpoints of all four sides of the resulting southeast quarter of the southeast quarter must then be established and a "straight line" run between these opposite midpoints to establish the center of the southeast quarter of the southeast quarter of the section.

The midpoints of all four sides of the resulting southeast quarter of the southeast quarter of the southeast quarter must be established and a "straight line" run between opposite midpoints to establish the

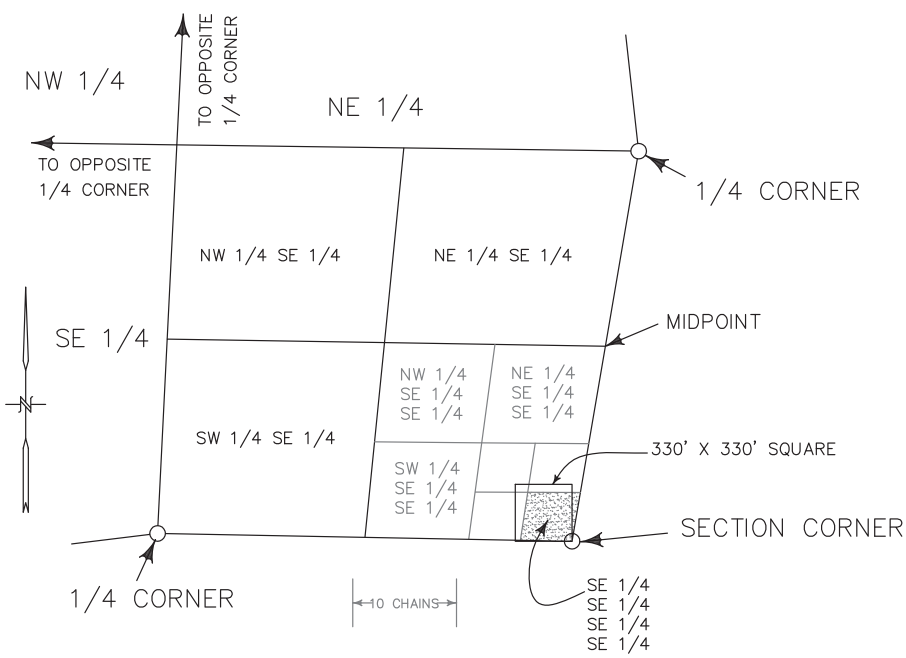


FIGURE 7.11

center of the southeast quarter of the southeast quarter of the southeast quarter of the section. Only this procedure will result in the correct monumentation of the described parcel.

Most of the steps that established the midpoints of land lines and the “runs” between opposite sides can be, and almost always are, the results of computations, as opposed to actual field monumentation. The only field work that is absolutely necessary in this case is the recovery of all four quarter corners of the section, the southeast section corner, and the monumentation of the three remaining corners of the parcel. Survey plats or maps of USPLS sections or their aliquot parts that report exactly the same distances and directions as the original government plat are almost certainly the result of incorrect work.

If the reader believes that Figure 7.9 offers an overly pessimistic view of a typical section, instead of a regular occurrence, now is a good time to recall the conditions under which most of this work was done.

The bulk of the work was done under contracts that paid by the mile. Nineteenth-century work was typically contracted at less than 10 dollars per mile. Out of this fabulous sum, the government surveyor had to provide for the payroll and equip the crews with chains, compasses, tents, food, mules, wagons, brush knives, axes, posts, firearms, and other necessities. Whatever remained was the government surveyor contractor’s profit. It may be possible that some of the surveys were hurried or that some of the work didn’t follow the general instructions to the letter. Perhaps there may even be one or more instances of fraudulent field notes being returned to the surveyor general’s office.

Considering the wild condition of the land, the rough terrain, the crudeness of the instrumentation and techniques, the hostility of the indigenous population, and the demand for haste, one can only be amazed that any dimensions and directions reported were even close. The wisdom of relying on the actual location of the original monumentation over the purported dimensions becomes more evident as the examination of the physical limitations of the original surveys is reviewed.

7.2.10. Nonaliquot Division of a USPLS Section

Care must be taken when regular sections are being divided that the intention to divide along lines that are not aliquot parts is not confused with those that are. The best assurance of this is the creation of a subdivision plat, the assignment of lot numbers to the parcels created, and the recording of the plat. The written instruments that document the sale could stress the intent to deviate from the normal process of

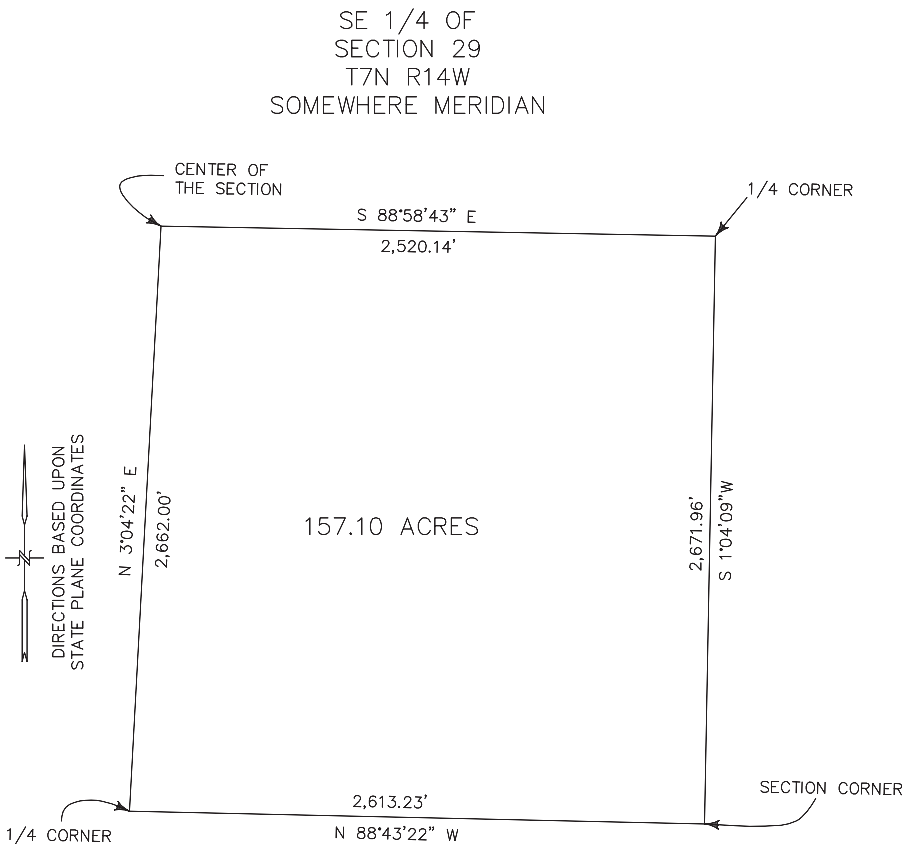


FIGURE 7.12

dividing regular sections. Finally, all reference to fractions, such as $^1/_2$ or $^1/_4$, should be avoided. The use of examples may better clarify situations that dictate deviation from the aliquot methods.

Figure 7.12 is of the SE$^1/_4$ of Section 29, T7N; R14W Somewhere principal meridian. Naturally, there has never been a survey conducted on this quarter section, since the government surveyor set the corners in 1890. Everyone "knows"[26] that this quarter section is 40 chains to a side and contains 160 acres. The dimensions shown in Figure 7.12 are the actual dimensions that would be revealed by a modern survey.

The owners have two sons, and they want to give each an equal portion of the property. Suppose number one son is deeded the N$^1/_2$ SE$^1/_4$ Sec. 29 and number two son is deeded the S$^1/_2$ SE$^1/_4$ Sec. 29. Figure 7.13 shows the resulting division.

[26]Remember Will Rogers.

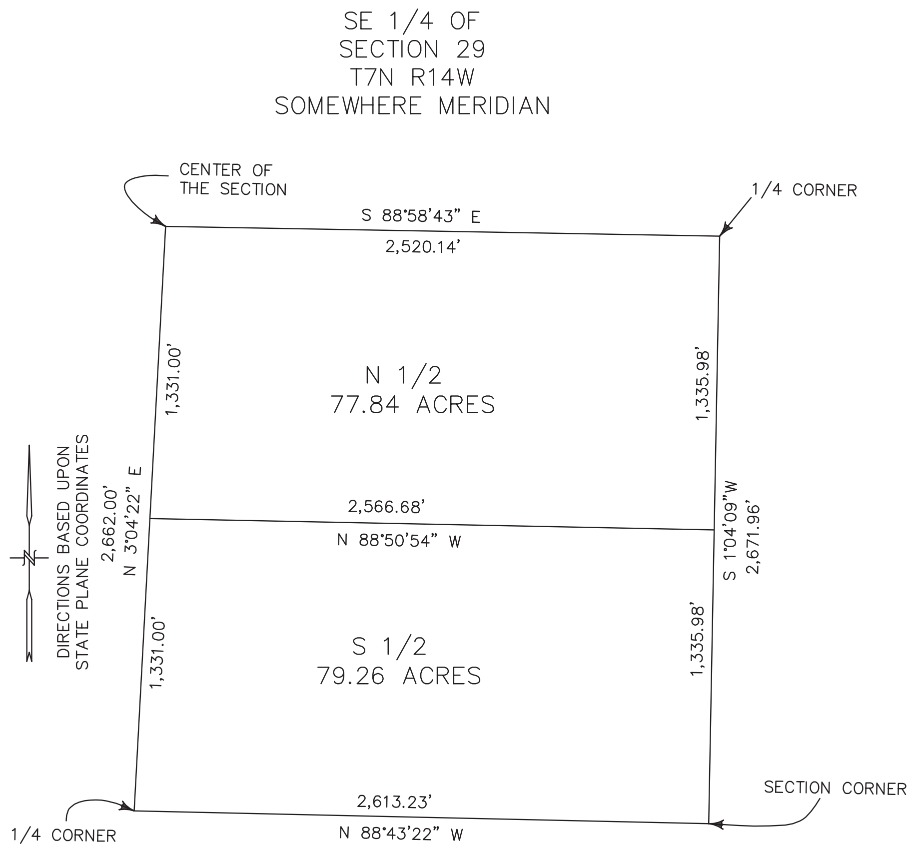


FIGURE 7.13

The division is not equal. The situation could be even more complicated if number one son were to measure south 1,320 feet from the north line of the SE$^1/_4$, fence the property, and begin cultivation, confident that he is in possession of his 80 acres. In reality, he possesses 77 acres, because the fence is 10–15 feet north of the correct location. This seems trivial until number two son sells the land to a manufacturing company that builds a warehouse 5 feet from the fence.

7.2.11. Private Claims

More often than not, especially in the Mississippi Valley, the government surveyor encountered lands that had been claimed and settled prior to any surveys. In most cases, the private claim was just bypassed, as if it were a large lake. This disruption of the "regular" pattern caused the formation of irregular sections. The section numbering system was adhered to, as nearly as possible, in these cases, with some notable exceptions. The treaty that concluded the Louisiana Purchase required the United States to honor all existing land grants and claims and to conduct surveys of these parcels so that the U.S. Congress could confirm these claims.

This resulted in some very interesting township plats. Surveys of heavily populated areas often produced entire townships where not one regular section occurred. Rarely did the U.S. Congress or the government surveyor make any attempt to rectify preexisting boundary disputes arising from the overlap of private claims and royal land grants. Each confirmed claim was given its own section number, causing some townships to have well over 100 sections.

Plate 7.1 is a photo-reduction of a township plat that was approved by the surveyor general of Louisiana on August 19, 1853. The field work and notes that were used to develop this plat were begun in 1829 and completed in 1853. Note the meander line along the Mississippi River as well as the absence of a regular section. The table of contents reports 5,165.58 acres of private claims and only 323.41 acres of public lands in this township.

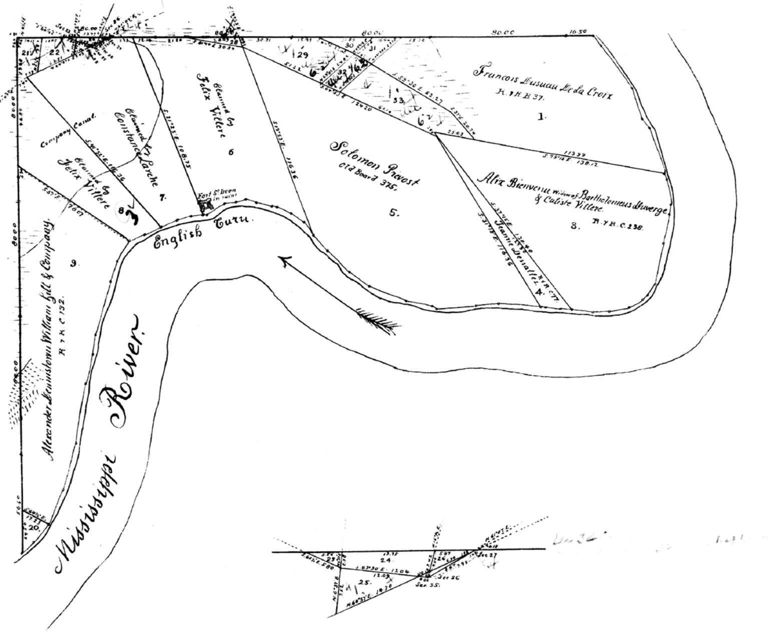
Divisions of irregular or "fractional" sections are provided for in the regulations controlling the division of public lands, but such highly irregular sections as are shown in Plate 7.1 defy any semblance of regular division. In many areas, where such settled conditions existed long before the USPLS implementation, the owners, attorneys, and even the courts continued to use the metes and bounds system of property identification. It is very common, in southeast Louisiana, for example, for a real property chain of title to be devoid of any reference whatsoever to section number, township, or range. These areas, although officially in USPLS states, are acting as metes and bounds areas.

7.3. PLATTED SUBDIVISION OR URBAN SYSTEMS

The metes and bounds system and the USPLS discussed so far are systems that are most effective when they are used for large tracts of land. The original land grants of the colonies and the USPLS sections typically transferred land for some agricultural use. Both systems allow for division into very small parcels, but they lose effectiveness or become unwieldy as the size of the parcel decreases. This is especially true for the USPLS. The formal USPLS rules only specify the aliquot division process to the one-sixteenth of a section. The division of

T. 14 S. - R. 25 E. South Eastern District, La.

West of Mississippi River



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Public Land

Sec	Area	Sec	Area	Sec	Area	Sec	Area	Sec	Area	Sec	Area	Sec	Area	Sec	Area	Sec	Area
21	30.9	22	27.64	25	4.56	27	0.01	28	6.60	29	95.68	32	26.56	33	131.08	34	0.32

Total Area of Public Land 323.41 Acres.

Private Claims

Sec	Claimants Name	Report Name	Report Date	Report No.	Area	Sec	Claimants Name	Report Name	Report Date	Report No.	Area
1	Francois Dussuau de la Croix	R & R	Sept 5th 1833	B. 37	835.79	23	Edmond Fazende and Francois Fazende	R & R	Sept 5th 1833	C. 4	0.66
3	Alix Bienvenu Widow of Bartholomew Duverge & Calixte Villere	R & R.	"	C. 238	807.66	24	Thaddeus Mayhew	Regr	Jan 6th 1821	19	4.19
4	Jeanne Dessalles wife of Pierre Dulcide Baran	"	"	C. 77	77.87	26	Antonio Marcellin Ducros and Casimir Lacoste	R & R	Sept 5th 1833	C. 240	0.90
5	Solomon Prevost	Old Board		375	1216.02	30	Michel Andry and Hortaire Andry	"	"	C. 56	15.73
6	Claimed by Felix Villere	No confirmation found			587.67	31	Marie Constance Larche	"	"	C. 30	21.21
7	Claimed by Constance Larche	"	"	"	508.18	35	Thaddeus Mayhew	Regr	1821	19	0.02
8	Claimed by Felix Villere	"	"	"	302.88		Cl. by Constance Larche	No confirmation found			
9	Alexander Dennistoun, Wm Hill & Company	R & R	Sept 5th 1833	C. 132	770.50	36	Antonio Marcellin Ducros and Casimir Lacoste	R & R	Sept 5th 1833	C. 240	0.14
20	Felix Martin Fontall & Alexr Gordon	"	"	C. 2	20.06						

Total Area of Private Claims 5165.58 Acres
" " of Township 5488.99 " "

Traverse of Mississippi River.

Sec	Course	Dist	Sec	Course	Dist	Sec	Course	Dist	Sec	Course	Dist	Sec	Course	Dist	Sec	Course	Dist
1	S.32½ E	7.20	3	S.12½ W	23.68	4	N.80½ W	1.88	5	N.43½ W	12.09	6	S.63½ W	11.36	9	S.19½ W	11.38
"	S.37° E	30.78	"	S.33° W	8.08	5	N.66½ W	25.74	6	N.39° W	8.65	"	N.75° W	1.13	"	S.15½ W	83.95
"	S.17° E	19.14	"	S.47° W	7.80	"	S.86½ W	12.98	"	N.48° W	8.70	7	S.86 W	6.83	"	S.8° W	11.70
"	S.32¾ E	6.80	"	S.61° W	9.08	"	S.87½ W	23.00	"	N.65 W	10.26	"	S.70 W	8.50	"	S.15½ W	17.66
"	S.19½ E	28.12	"	S.78½ W	12.50	"	N.64½ W	2.96	"	N.88° W	2.80	"	S.54 W	2.20	"	S.10° W	24.11
3	S.17½ E	2.90	"	S.88° W	9.60	"	N.77¾ W	16.00	"	N.75° W	9.90	"	S.67½ W	8.75	"	S.15° W	27.89
"	S.67¾ E	15.06	"	N.82° W	13.20	"	N.67° W	23.00	"	N.81½ W	6.80	8	S.64° W	10.12	"	S.27½ W	21.85
"	S.8° W	5.65	4	N.78° W	7.50	"	N.56° W	14.03	"	S.68½ W	5.87	"	S.72½ W	9.60	20	S.38¼ W	14.42
"	S.10½ W	17.40	"	N.85½ W	8.00	"	N.43° W	18.05	"	S.84¼ W	7.24	9	S.31 W	12.65	"	S.48° W	8.75

Variation of the Needle 7°57' East

John Maxwell D.S. Surveyed the North Boundary in the 4th Qr of 1829 and was paid in the 2d Qr of 1830 he surveyed Sect 1.23.24.26.30 & 31 and all the lines of Public land in the 1st Qr of 1830 and was paid in the 3d Qr of 1830.

William H. Cobb D.S. Surveyed the remainder of Township in the 1st Qr of 1830 he was paid for the West Bdy and the Traverse of Mississippi River, in the 2d Qr of 1830 but no evidence of payment for the remainder

William Sevey D.S., under contract of 3d March 1853 and Instructions of 7th February 1851 and 12th March 1853 resurveyed the whole Township in the 2d Qr of 1853 - The North Bdy is included in his account approved August 19th 1853

All the sections of Public Land contain Swamp Land accruing to the State of Louisiana under the provisions of an Act of Congress approved 28th September 1850 See List herewith transmitted

Mr Sevey preserved the old boundaries and the old corners wherever found.

Surveyor Generals Office
Donaldsonville La August 19th 1853

The above Township Map has been examined and compared with the approved field Notes thereof now on file in this Office found correct and is hereby approved except Such Sections for which no confirmation have been found

Wm J. McCulloh
Surveyor General Louisiana

PLATE 7.1

USPLS sections into smaller fractions is only an extension of these rules and can become quite clumsy (see Figure 7.7).

Very early in the metes and bounds system, and later in the USPLS, landowners often wished to divide their large tracts into smaller parcels. One of the ways in which this was frequently done was to produce a subdivision plan or plat in which the smaller parcels were identified by a lot number or some other identification. This plat was then recorded in the local conveyance office, and any title transfers would refer to the subdivision name and lot number.

This system has many advantages. In urban situations, where public streets are created, the addition of the concept blocks greatly reduces the verbiage needed to describe any particular lot. The plat can be used by the owner as a sales aid. Buyers can readily see on the plat, if not on the ground, the configuration of the property being purchased. The tax collector can use the plat to develop a record of the ownership and relative worth of the properties. Deeds that refer to lot and block identifiers may be supplemented by a metes and bounds description, which refers to street right-of-way corners and adjoining lots to confirm the lot and square.

The platted system of real property identification has one very important distinguishing feature that greatly separates it from the metes and bounds system and the USPLS. Unlike the previous two systems discussed, the platted subdivision does *not necessarily depend on monumentation or possession* to create boundaries to the property. Before local governments began to exercise their authority, it was not uncommon for owners to draw a platted subdivision of their property solely based on the old metes and bounds system or USPLS description. It may be that *none* of the corners in the subdivision was ever monumented. It is just as possible that the platted subdivision was properly performed and that all of the newly created corners were monumented. The consequences of both cases will be discussed at length in Chapter 10.

Platted subdivisions should be separated into two additional categories. Subdivisions in which all of the lots were platted and recorded at one time are very different from subdivisions in which the lots were created one at a time. If the former is true, none of the lots can claim "seniority of title."[27] If the lots are created and sold one at a time and some chronological sequence can be established for the transfer of title, then a seniority of title can be established.

[27]"Seniority of title" refers to the concept that, in the sequential division of land, the parcel sold first must conform, as closely as possible, to the monumentation and dimensions called for in the deed. Parcels sold at a later date must yield to the senior deed in cases of conflict.

Survey markers set at the corners of a platted subdivision do not have the same ranking as corner monumentation by the government surveyor in the USPLS, nor does a survey marker set hold the same status as a corner called for in the metes and bounds description. A platted subdivision usually expresses the intent to convey a parcel of property of specific dimensions. The survey markers, if any are set, reflect a corporeal attempt to place on the ground the limits intended by the survey plat. Any blunder in the setting of these survey marks can be corrected at any time, provided that correction is geometrically possible and sufficient acquisitive acts have not taken place.

Frequently, only the street rights-of-way were monumented by the original subdivider. This created the blocks or squares of the subdivision but did not monument the individual lots. In general, it is public reliance on the monumented location of the street rights-of-way that will, in most cases, causes any excesses or deficiencies to be isolated within each block. It is because of this public reliance that block corner monumentation usually ranks above lot corners in importance during boundary recovery.

In order for a Land Surveyor's marker to mature into the kind of artificial monument that is referred to in the hierarchy of calls, reliance on that marker and the rules of acquisitive prescription must be satisfied. A private Land Surveyor's marker must satisfy several conditions. "Not every cross upon a stone does a corner make, nor each iron pipe a monument" is an amusing but wise phrase.

Unlike USPLS or original private claims, platted subdivisions typically create land parcels that are quite small. Because of their small size, along with the fact that most platted subdivisions are relatively modern, it is more likely that resurveys of individual lots will discover the dimensions to be identical, or at least very close to, the dimensions reported on the original subdivision plat. More often than not, this is because the typically short distances encountered in modern platted subdivisions reduce measurement errors to values that are less than the inherent errors produced by centering on corner monuments.

For example, let us assume that a particular lot in a platted subdivision is reported to be 200 feet from an intersection, 100 feet wide and 200 feet deep. The block corners were originally monumented by one-inch diameter iron pipes and the lot corners by $^3/_4$ diameter iron pipes. A Land Surveyor, recovering the monuments and measuring 200.02 feet and 99.99 feet, respectively, will, in all likelihood, report the original 200 and 100 feet, because the variation from the record is within normal standards of precision.

CHAPTER 8

THE GLOBAL POSITIONING SYSTEM (GPS)

8.1. OVERVIEW

The Global Positioning System (GPS) in operation around the world first began as a U.S. military navigational program. The American constellation of satellites is still operated, maintained, and supported by the United States Air Force.

Other nations, or groups of nations, have begun to establish their own navigational systems based on the U.S. model. All of the systems were, and are, primarily navigational. The use of these systems for precise, centimeter-level positioning was completely unanticipated.

Initially, the U.S. government, for security reasons, would scramble signals or not release frequencies and codes in an effort to reduce the positioning precision of nonmilitary GPS receivers. The ingenuity of the private sector was not to be denied. The methods and equipment developed were able to achieve land survey–level precision by essentially eavesdropping on the signals without the ability to "read" all that was being sent.

The modern Land Surveyor uses signals sent from every positioning satellite constellation in orbit without regard to which government(s) is maintaining that system. Land Surveyors and users of survey information must have a broad understanding of the capabilities and liabilities associated with this very powerful addition to the Land Surveyor's toolbox.

8.2. FUNDAMENTALS

Unlike all of the other systems established to navigate the earth, GPS is not a surface-based system. Until the space age, every mechanism used to map and navigate the earth was anchored on the surface of the planet.

Latitudes were based on the rotation of the earth as determined by observations of the stars made while standing on the ground. Longitudes were established by arbitrarily naming a location the starting point and then measuring the time differentials between when certain stars were vertical at an unknown site and the arbitrarily chosen meridian.

The positioning system chosen (latitude, longitude, and elevation) was spherical and particularly useful for observers that were on, or very near, the surface of the earth.

GPS has approached the problem of positioning from a radically new direction. The system is based on the center of the earth, not a location on the surface. The coordinate system used is a three-dimensional rectangular system. One axis of the system coincides with the axis of rotation of the earth. The other two axes are fixed at defined, but essentially arbitrary locations. All of the axes are mutually perpendicular.

GPS receivers use the signals from the satellites to compute the receiver's location in terms of an x, y, and z. It is only through a very complicated and rigorous set of computations that these rectangular spatial coordinates are translated into the spherical geodetic positions we use.

The translations to elevation are even more complicated. The geodetic positions are on a mathematically defined surface, the ellipsoid, and a function of distance from the center of the earth. Elevations are on a surface, the geoid, which undulates according to the gravitational attraction of the planet. It is only through extensive and comprehensive measurements that the relationship between the gravitational surface and the theoretical surface can be mapped.

This is a continuing process. As the observations become more numerous, the mapping of the differences provides the Land Surveyor with the information needed to precisely measure elevation differences over greater distances. Some areas of the earth have been mapped more densely than others, so GPS derived heights are not yet uniformly precise. This will change as use increases.

8.3. GPS AND LAND SURVEYS

GPS broadcasts signals laden with data that capable receivers use to compute the receiver's position. The precision of these locations are to within 20 meters or so without any additional information. This is certainly not precise enough for land surveys. The addition of a corrections-receiving radio to the GPS receiver can improve the level of precision to about five meters or so. Land surveys require the level of precision to be a few centimeters. That precision is not yet available for a single receiver.

The deliberate signal variations and natural anomalies that perturb the location signals as they enter the atmosphere on the way to a receiver are so unpredictable as to render centimeter-grade raw positioning very difficult. The solution that the survey profession hit upon was nothing less than brilliant.

Let us suppose that one receiver is placed on a point of known geodetic position (base station) and others placed at locations of unknown geodetic positions (rover stations). If the ones placed at the unknown locations are not too far from the one that is at a known position, then the distortions of the signals from a common satellite should be about the same for each receiver. The errors in the computed position caused by ambient conditions would be the same for both. Therefore, the differences in the values computed for the position of each must be the result of the relative distances between the receivers. In this manner, the geographical relationship between the receivers can be very precisely computed.

It is in this differential mode that the Land Surveyor has adapted what was intended as a navigational aid into a mechanism by which distances and directions can be measured between points on the earth's surface that are not intervisible. The only requirement is that the receivers are operating at the same time, under similar atmospheric conditions, in locations with a clear view of the sky, and they are observing enough of the same satellites.

Horizontal distances of several miles can now be measured with a precision comparable to line-of-sight electronic instrumentation but with greatly reduced expenditures of effort and time. Depending on the level of precision required, the distances measured can be continental.

Fifty miles from the base station is usually considered as the outer range of reliable horizontal differential measurements. Vertical differences are much more susceptible to distortion and the distance from the base station is reduced to five miles. Both of these limits are functions of range, procedure, and equipment. The future promises pronounced improvements in the range at which reliable horizontal and vertical data can be collected.

The adaptation of GPS techniques to land surveys is rapidly advancing. There are presently a multitude of variations and improvements to the differential application of GPS technology for land surveying purposes. (Those interested in a more thorough explanation are referred to Jan Van Sickle, *GPS for Land Surveyors,* 3rd ed. Boca Raton, FL: CRC Press, 2008, as an excellent starting point.)

8.4. CORS NETWORKS

GPS technology, as adapted by the Land Surveyor, is dependent on at least one receiver's being at a known location. It often occurs that the effort required to recover and occupy a station of known location that is GPS observable and within range of the area to be surveyed is significant. The idea arose that instead of hunting up NGS control stations with a good view of the sky, the Land Surveyor could determine the geodetic position of a permanently mounted receiver antenna in a central location.

The rover stations then become the only portable part of the operation. The base station could be housed in a secure building, like the home office, further reducing the personnel required and time expended performing a set of GPS measurements. As long as the base is receiving satellite data at the same time as the rovers, land survey grade differential measurements are possible.

From this came the concept of continually operating receiver stations (CORS). In this case, the base station is never turned off. Rover stations could then be operated when conditions were right and the data compared to the base later. Better yet, a network of CORS with overlapping ranges could be used by a single rover to develop a position that was not dependent on one fixed location.

Today, CORS systems have been established throughout the United States and elsewhere. Local, state, and other organizations, in cooperation with the National Geodetic Survey (NGS) have systems in operation that will allow any GPS operator to submit the digital data downloaded from their receiver to the NGS for processing. This system is Internet based and maintained by NGS under what is known as the Online Positioning User Service (OPUS).

This powerful and useful service offered by NGS has done as much as or more than any other technology of the 21st century to advance the capability of the Professional Land Surveyor. Geodesy and boundary surveying have become closer in goals and capabilities. Procedures, data collection, and map projections systems have been somewhat standardized as a result of superior results, not mandates. Indeed, the many standards, regulations, and rules established by governing authorities or professional organizations lag far behind the rapidly advancing state of technology.

8.5. PRACTICAL APPLICATION

The survey example in section 6.11 was based on the availability of the NGS horizontal control stations "Billy" and "Bob." The network of NGS control stations throughout the United States was typically concentrated along the coastlines and transportation corridors. The vast majority of the land area was not well supported by control stations.

More often than not, the Land Surveyor did not have monuments of known geographic position to rely on within a reasonable distance of the project. This is no longer the case. The ability of the GPS receivers to measure the distances between locations that are many miles apart to a level of precision that, over such spans, was heretofore unheard of provides NGS supported geographic positions to every Land Surveyor everywhere in the United States or the world.

Figure 8.1 is an example of how high-quality State Plane Coordinate (SPC) data can be developed for surveys that are in remote locations. The remainder of the survey work follows the same procedure as the random traverse outlined in section 6.11.

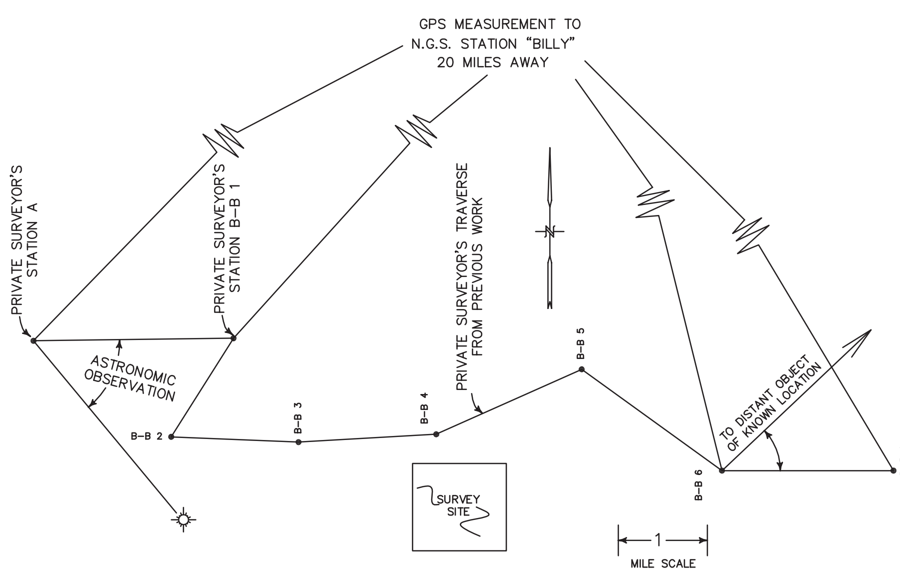


FIGURE 8.1

Notice that the bearings between the control stations have been verified by a method independent of GPS technology. Independent verification is an economic alternative to the multiple (at least three) GPS observations recommended to develop sufficient redundancy of observations. Even small horizontal positional errors between stations in close proximity can produce directional errors that can be magnified during the traversing process, so redundancy in developing positional data or directional observations that are not dependent on stations in close proximity are used.

Many states, perhaps soon to be all states, are creating CORS networks. One variation of the GPS differential measurement procedures, known as Real Time Kinematic (RTK) positioning uses radio communications between the base station and the rover to develop position solutions that are displayed on the rover as soon as the solution is computed. The operator is provided with the receiver location within seconds: "in real time."

RTK has proven to be a very effective topographic data collection and construction control stake-out tool. This procedure requires a full and uninterrupted view of the satellite constellation to be effective. However, even when used in close proximity to the control stations, RTK is not as precise as are other positioning methods. The CORS network developers are investigating a radiophone version of RTK for general use.

Positioning technology is advancing with almost daily developments and improvements. When it is appropriate to use one or more of these powerful additions to the Land Surveyor's options is a professional decision that will be based on more than just the client's needs. In the case of recorded real property transactions and activities, the land boundary information obtained by the Land Surveyor must be capable of assimilation into the community's record and recovery systems.

8.6. STRENGTHS

The great advantages presented by GPS technology are ones of scale and sustainability. Great distances between land points are no obstacle. No longer must locations be intervisible in order to measure between them. The adoption and use of national geographic positioning systems, such as SPC, is within the reach of every survey and Land Surveyor.

Locations recovered and documented using reliable nationally supported positioning criterions are more easily recovered and can be compared to data developed by other Land Surveyors at different times.

This data can be directly imported into local, state, and federal Geographical Information Systems (GIS) used for everything from land record keeping to infrastructure maintenance.

8.7. WEAKNESSES

The ease with which GPS observations develop precise geographic positions often causes a user to become overreliant on the numbers that come out of the computer. The temptation to use a position obtained from a single GPS observation and "run with it" is great.

Notice that in the example in section 8.5 the Land Surveyor had four locations that were processed and tied together by standard line-of-sight (LOS) measurements into a network. If one of the GPS observed locations contained large errors due to a regional anomaly, the inconsistencies between computed and LOS measured distances and directions would alert the Land Surveyor to a problem. Manufacturers of GPS receivers correctly tote the very small deviations that are attained with "95 percent certainty."

In other words, 5 percent of the time the data has location errors that exceed the published level of precision. Statically, in a set of four measurements that are "95 percent certain" the odds are one in six that one of the four contains an error that exceeds the 95 percent deviation. The magnitude of any particular 5 percent deviation may be significant. For this reason, no horizontal or vertical position derived from a *single* GPS session should be considered sufficient for land boundary survey control.

8.8. COPING WITH REALITY

The constraints that face a Land Surveyor during a land boundary survey are several. The time, effort, and expense associated with the degree of precision obtained by survey procedures must be economically and legally justified. Once the level of precision has been determined by the Land Surveyor, the equipment and procedures are tailored to meet that need.

In the GPS world, the level of precision is relatively high, with the exception of an occasional anomaly. Sometimes, for reasons that have not been adequately explained at the time of this writing, the data set from a GPS observation will provide a solution that is far beyond the expected error limits. These "fliers" are rare but can be devastating.

Prudent GPS procedures require a level of redundancy in observation that will identify and eliminate such fliers from the control network. There are many methods of obtaining redundant observations but the most effective and economical combine GPS observations with LOS measurements.

For example, GPS data can be collected at three intervisible stations. This is most effective when the data sets are collected on different days. LOS measurements can then be made between the stations recording both distances and angles. If the LOS results are consistent with the computed GPS positions, the data set is verified. If there is a flier, the remaining two stations that are in agreement can be used.

LOS verification of the direction between two intervisible GPS stations by astronomic or distant sight points is another very effective means of verifying GPS results. LOS verification of the distance between two GPS stations is a must, but distance alone is insufficient to verify GPS results. LOS distances combined with angular or bearing measurements are both required to confidently verify location data.

Sun or Polaris observations are highly accurate and very simple. The geodetic azimuths are easily reduced to SPC bearings. The precision of the directions obtained by astronomic measurements is commonly repeatable to within 5 seconds or so. This is more precise than the directions derived by inversing between high-precision GPS stations that are less than 2,000 feet apart.

Distant sight points, such as television or radio transmission towers, are usually associated with published geodetic positions that have been determined to a high degree of precision. The bearing to these locations can be computed and used to verify the relative positions of GPS stations within the survey network. Distant sight points often become "permanent back sights" for Land Surveyors working on extended projects in an area.

A GUIDE TO UNDERSTANDING LAND SURVEYS
STEPHEN V. ESTOPINAL

CHAPTER 9

THE GEOGRAPHIC INFORMATION SYSTEM (GIS) REVOLUTION

9.1. BUILDING A FOUNDATION

The profound increase in the sheer amount of land information that has become available to everyone has been nothing less than a tsunami. Users of land information are now confronted with the task of assimilating, cataloging, and storing all this information in a way that it can be recovered and used.

The systems that have been developed to control land information are collectively known as Geographic Information Systems (GIS). It is "geographic" because the information is linked to the earth. This is not just geography; this is everything that can be associated with a location.

Technically speaking, every map is a geographic information system. Any agency that has had to study or manage land-related matters would develop maps on which pipelines, streets, crops, population, or whatever was being investigated would be indicated by symbols. The list of things that can be mapped is endless, and any information that can be mapped is geographic information. The electronic process is analogous to a base map over which selected transparencies containing the information of interest are placed.

The big improvement in the electronic GIS programs is that anybody can use it. The data can be stored in many different locations by the owning agency and summoned by users in far-off locations with ease.

The linchpin, the keystone, the foundation, the one piece of information that links it all together is *location*. In the United States, the base map of an effective GIS program is geodetic positioning controlled by the National Geodetic Survey (NGS)-supported North American Datum of 1983 (NAD 83) geodetic model. Jurisdictions will often convert the geodetic positions of latitude and longitude into the more user-friendly State Plane Coordinate (SPC) system. But, nevertheless, precise and reliable positioning must be available in order to initiate an effective GIS program.

9.2. SOURCES OF INFORMATION

The Electronic Age has prompted the many different owners of geodetic information (maps) to convert that information into digital format. First by digitizing existing paper scaled maps and then by developing maps by computer-aided drafting (CAD) programs, what were once paper drawings stacked in filing cabinets slowly became replaced by digital data sets that could be viewed only by computer programs.

The precision and reliability of the data found in these data sets are very much a function of the means and methods used to develop them. One of the primary methods of developing digital data from a paper map is known as "digitization." In this process the paper drawings are placed on a pad laced with sensors and the lines on the paper are traced. Digitized electronic maps can never be more precise than the original paper plan.

Digitized maps can then have information added to the electronic version that was not a part of the original paper map. Municipal, county, state, and federal agencies often place the data associated with their function over digitized topographic maps, aerial photographs, or other sources of control that mimic geodetic control as the base when, in fact, a digitized map is the base map.

The distances, locations, areas, elevations, and bearings computed from a GIS program can be only as precise as the original source of that information.

9.3. SYSTEM MAINTENANCE

GIS programs must be maintained to be of any use. This may be best explained by example. The Public Works Sewerage Division of a municipality instituted a GIS database for all of the facilities in their system. The first step was to collect all of the existing maps of the sewer lines they own. These maps were digitized and then electronically scaled and rotated to fit a street map (also digitized) of the municipality. The locations of the lines in this initial layer are no more precise than the old paper maps.

In order to improve the precision of the GIS data, it was decided to determine the geodetic position of all manholes and visible structures. The cost of using a survey crew to do this work was prohibitive. Aerial photography was used instead, and the geodetic position of items determined by scaling or overlaying the photo onto the base map. This reduced the locative uncertainty from tens of feet to a few feet. Even though this was not as precise as it could be, it was a great improvement over what had existed.

Ideally, anytime repair work was done on the system, a survey crew would precisely determine the geodetic position of the exposed pipes. However, because of cost, handheld *navigational gps* units were employed to collect the new data. These radio adjusted units provided locations with a precision of less than five feet. This was about the same level of precision as that provided by the aerial photography.

New work by developers or under facilities improvement contracts required surveyed geodetic positions, converted to SPCs, for all new structures. This was made easier when the municipality adopted a continually operating receiver station (CORS).[1]

It was in this way that the example agency developed and continues to maintain the GIS database of their facilities.

9.4. POTENTIAL USERS

It may be simpler to list data users that would not utilize a GPS data source. If the item of interest involves "where" in any of its attributes, it is an item that can be, and soon will be, a part of a GIS database somewhere. From soil types to rainfall patterns to ownerships to demographics, data will be, and is being, complied in a GIS digital format. It is vitally important that the persons directing the locations and recordation of these data be aware of the need for a firm foundation, a valid base map, on which this data is to be presented.

9.5. POTENTIAL FOR MISAPPLICATION

GIS is a powerful tool and, as it is with many powerful tools, if mishandled can cause much grief. The user need not be aware of all of

[1] See section 8.4.

the nuances of the data collection procedures, but a firm understanding of the *limitations* of the particular fragment of the GIS data base is vital.

An inquiry made electronically by "clicking" on a property line, for example, may result in a answer of a distance to the one-hundredth of a foot and a direction to the second, yet the GIS data may have originated with a digitized paper map wherein the original drafting precision was dozens of feet one way or another. GIS data often use SPCs or other rectangular map projections. Even distances that are precisely determined on the earth's surface will be adjusted to some degree because of the requirements of the map projection in use.[2]

Users of GIS sources must know where the data comes from and apply the results of a query accordingly. Most people, particularly the novice, have the disconcerting habit of believing anything that a computer spits out. GIS users must constantly strive to wisely assess sources and application.

[2]See section 5.5.

CHAPTER 10

BOUNDARY RECOVERY

Contrary to popular belief, Land Surveyors do not establish boundary lines. Boundary lines can only be established by the landowners, although disputes may be settled by adjudication.

The act of subdividing a parcel of land by a private Land Surveyor acting as an agent of the property owner, or the monumentation of section corners by the government surveyor in the case of federal lands, is the first step in the process of establishing the boundaries of newly created parcels. These are the “original steps” that all descendants in title, and the Land Surveyors working for them, are bound to follow.

The Land Surveyor is charged with the task of recovering those boundaries, not establishing them. The original boundaries can be established only once when the owner divides the lands. All surveys after that original establishment are boundary recoveries.

A boundary recovery by a Land Surveyor constitutes a *professional opinion* and is no more binding on the property owners than the advice of any other professional. Every property owner has the right to reject a purported boundary recovery if that owner so desires.

10.1. RULES OF EVIDENCE

Boundary recoveries are opinions rendered based on the results of an investigation. The rules of evidence that are applied to that investigation are not very different from the rules of evidence in a civil proceeding. Every item discovered during an investigation is evidence. There are no exclusionary rules for a Land Surveyor. Parole evidence, hearsay, private documents, recorded documents, and anything else may be considered or may point the way to further investigation and discoveries. Physical evidence is generally more reliable than testimony, written evidence is given more credence than parole, and recorded evidence is given more weight than private, and so on.

The hierarchy of calls (see section 7.1) used to assist in the interpretation of deed descriptions also guides the Land Surveyor in evaluating boundary evidence. Natural and artificial monuments are physical evidence. A survey plat may be a physical thing, but the measured angles, distances, and computed areas shown on that plat are the recorded observations (testimony) of the previous Land Surveyor. Neighbors and landowners often offer undocumented (and sometimes biased) opinions with regard to the location of boundaries. The Land Surveyor weighs all of the evidence and, based on the quality and quantity of the evidence, renders an opinion on the location of a boundary.

10.2. SOURCES OF EVIDENCE

Title examinations are usually restricted to recorded documents. The deed document and recorded survey plat are far from the only source of evidence used by the Land Surveyor in recovering real property boundaries. Because the location of real property boundaries is defined by the location of the real property *corners*, boundary recovery is, in fact, *corner recovery*. The primary source of evidence is the physical features discovered by the Land Surveyor in the field. Prior to conducting a field search for evidence, the Land Surveyor will use several other sources of evidence in an attempt to narrow the area of search for corner monumentation.

The deed document and previous surveys are obvious sources of evidence. Land Surveyors who have practiced in an area for a long time will have extensive files that may include deeds and plats of adjacent properties. The county records are also an important source of information on contiguous tracts of land. Land Surveyors can often be seen looking through the public property records book. They are not looking for a chain of title; they are searching for evidence pertaining to the location of the corners. Adjacent landowners often have plats or other documents that add details about the location of real property corners.

10.3. OFFICE PROCEDURE

Of all the questions commonly asked of the Land Surveyor, "Where do you start?" has to rank as number one.

The Land Surveyor is usually told the current land record identification of the particular parcel to be surveyed. That identification may be a lot number and subdivision name, an aliquot part of a section, a metes and bounds description, or just "the Jones's land."

As in a Greek tragedy that begins at the end before it returns to the beginning, the Land Surveyor must trace back through the public records and his or her private files to the original tract from which the present parcel was created. This "paper trail" may require many hours of research before any fieldwork is started. This step is greatly shortened if the Land Surveyor has previously surveyed other parcels of the same original tract. The value of prior knowledge in a particular area is a greater influence on the "regionalization" of private Land Surveyors than any other factor.

The theoretical starting point for any survey is the same whether a USPLS, metes and bounds, or platted subdivisions are involved. That theoretical starting point is the *record containing the creation of the original parcel*.

In the USPLS, that starting point is the government surveyor's original notes. In the case of the metes and bounds states, that starting point is the original land grant. In the case of the platted subdivision, that starting point is the original subdivision plat. In cases where the platted subdivision was not monumented, recorded, or public use and acceptance of the created streets has not taken place, the starting point reverts to the parent tract.

10.4. FIELD PROCEDURE

Once the Land Surveyor has gathered as much recorded and other written information as possible pertaining to the location of the real property corners, the field search for evidence of boundaries can begin. Each discovery is used to narrow the search for other corners.

The most difficult corner to find is usually the first corner. After the first corner is found, the area of search is greatly narrowed for subsequent corners, facilitating their recovery. Potential artificial corner monumentation must be compared with the record for consistency before it is accepted. Among the questions that need to be answered are, "Who set the monument?," "Has it been disturbed?," "Is its location consistent with other monuments?," "Is it of the same material as called for in the plat?," and so on.

Suspected corner locations are examined for evidence of the monumentation of record. The advent of the electronic metal detector has been as great an advancement in the land surveying profession as the computer and the electronic distance measuring device. Large areas can be searched electronically for iron-based monumentation, and the area excavated can be greatly reduced.

However, in the final analysis, the most important tool in the recovery of boundaries is the shovel. There are very few corner monuments that survive standing above the ground. The threat of earth moving equipment, brush cutting machinery, and other hazards—unintentional and otherwise—has led to the practice of burying boundary monumentation in order to ensure that the location of that monument is undisturbed.

The Land Surveyor may establish a control traverse first (see section 6.11), and/or measure from known corners or accessories to isolate the search areas, compute theoretical positions for the corners, and then intensify the search in those areas. Recovery of corners that were originally documented by state plane coordinates is faster and more reliable when the control traverse used in the recovery attempt is also based upon the state plane projection system.

There is no secret formula for boundary recovery, and the choice of measurement procedure made by the Land Surveyor is in many ways incidental to the success of the boundary recovery. A successful recovery is one that finds the natural or artificial monuments at the corners of a real property parcel.

10.5. RENDERING A DECISION

Rarely is every corner monument found in any boundary survey. The ravages of time and the activity of agriculture or land development frequently destroy many of the artificial monuments placed by the original surveyor. This does not mean that the location of the corner is lost.

The recovery of accessories to the corner reported by the original Land Surveyor is a recovery of the monumentation for that corner, even if the artificial monument at the corner is gone. Often, the location of buildings, tree or fence lines, or other terrain features in relation to the corner being sought were reported on previous surveys of the subject or adjacent tracts.

Certainty of recovery is directly proportional to the relative relationship of reported terrain features to the corner being sought. Recovery of the original and undisturbed monument set at the corner is absolute. Other features, such as witness trees or buildings that are a known distance and direction from the corner can be used to recover a corner.

Features that are nearer a corner, geographically and chronologically, are more likely to lead to a correct corner recovery than those that are more remote from the corner being sought. A known corner one mile away is not nearly as reliable as a witness tree 10 feet from a corner. A survey plat claiming to have recovered an original monument produced one year after that original corner was set is usually more reliable than one produced 100 years later.

The time and effort spent in searching for physical evidence of the location of a corner is the dominant factor. The greatest source of dispute among Land Surveyors about the location of real property corners can usually be traced to a failure to discover all of the physical evidence relevant to a corner location.

The tendency to simply "lay out" the deed dimensions of a parcel or to resort to mathematical computations that theoretically set the location of a corner often causes much confusion when, at a later date, additional physical evidence reveals the true location of the real property boundaries.

A Land Surveyor's professional ability is a function of his or her thoroughness in the collection of physical evidence more than any other single factor. Excellence in mathematics, beautiful plats, sophisticated electronics, or professional appearance are meaningless unless a Land Surveyor's boundary recoveries are based on all of the pertinent evidence that can be found.

Rendering a decision on the recovery of a property corner is an art. Formal education, continuing education, and extensive study will shorten the time it takes to excel in the art of corner recovery, but only experience in a particular geographical region will develop the skill needed for consistent and certain corner recovery. It is both proper and wise to request that a Land Surveyor inform you of the evidence and reasoning that led to the Land Surveyor's decision on the location of recovered corners.

10.6. USPLS BOUNDARY RECOVERY

Any survey of a USPLS section or *any aliquot part thereof* begins with the recovery of section corners and quarter corners. The best record of where any corner was set is the original notes of the government surveyor. Plate 10.1 is a photocopy of facing pages from a typical government surveyor's notebook.

Although most government surveyors' notes are arranged in this form, some notes may not be. The first column lists the direction of the line being "run." This line was typically a magnetic observation that was "corrected" for the local magnetic deviation. The "correction" involved marking on the ground a "true north" (actually astronomic north) line by observing the star Polaris at the headquarters of the government surveyor. The reading of a compass, usually very large and considered more "precise" than the surveyor's field compass, was then compared to the "true north" line, and the deviation of the needle from the "true north" line was recorded. This is why the deviation or declination recorded in many government surveyors' notes are reported to the nearest minute when the compass used in the actual work could only be read to the nearest quarter degree. Of course, the survey work was usually many miles away from where the magnetic "deviation" was measured.

The second column lists the distances along that line that terrain features or other items of note that were encountered as measured from the beginning of the land lines. These terrain features encountered along the survey route are known as "passing calls."

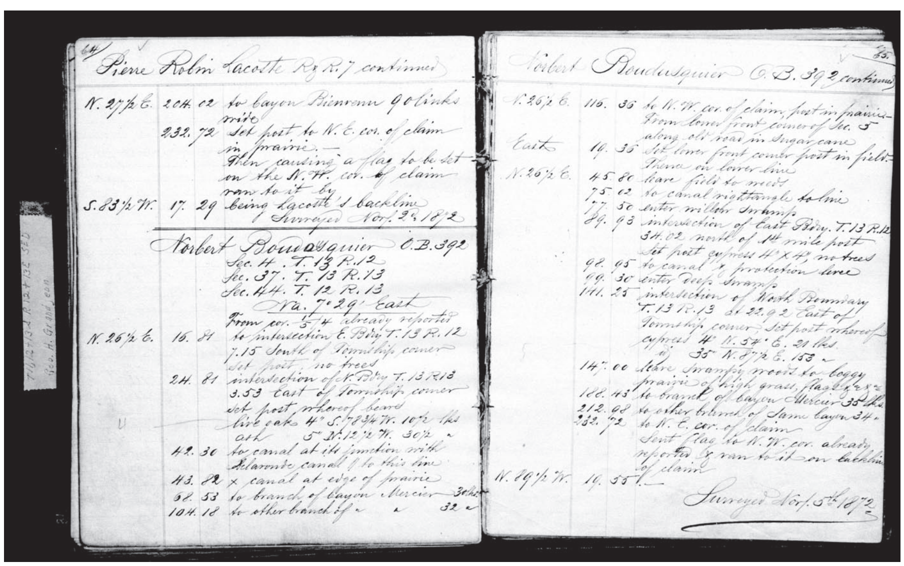


PLATE 10.1

Passing calls are frequently very useful in recovering corners set by the government surveyor, for they provide evidence of the location of the corner that is much closer than all other evidence, except for witness monuments (trees). If, for example, the notes indicated that at 38 chains from a found section corner the government surveyor crossed a small creek (in survey jargon, “a creek is called for at 38 chains”) and set a quarter corner at 40 chains, the first place to begin the search for the quarter corner is 2 chains past the creek, not 40 chains from the found corner.

The remainder of the page is reserved for a narrative describing and/or identifying the beginning of the line, the features encountered or “calls,” the end of the line, the corners set, and the *accessories to each corner*.

10.6.1. Accessories to a Corner

Accessories to a corner consist of physical objects near the corner to which distances and directions are noted for the purpose of future restoration of the corner. Accessories were most often natural objects, such as trees, and were sometimes referred to as “witness marks” or “bearing marks.” Accessories are as much a part of the corner monumentation as the corner post that may have been set by the government surveyor.

Witness trees are the most common form of accessory to a corner. These trees were chosen for their proximity to the mark, usually less than one chain (66 feet) away, as well as their size and species. In order to distinguish the accessory from other natural objects, the surveyor would scribe on the object specific letters or numbers.

Ideally, three or more accessories accompanied each corner and were chosen so that they encircled the corner. In the narrative portion of the notes, the surveyor lists the distance and direction *from* the corner *to* the accessory. Because the accessories are a part of the corner monumentation, a recovery of the accessories is a recovery of the original comer monumentation.

10.6.2. Recovered Corners

Corners that are reset by the use of accessories or by the discovery of the original, *undisturbed* monument are called “recovered corners.” Corners reset by use of the passing calls should not be considered as “recovered,” for passing calls rarely were in close proximity to the corner.

10.6.3. Deciphering Government Land Office (GLO) Notes

Line 10 of Plate 10.1 is the beginning of a line of a private claim. The line begins at the corner common to sections 1, 4, and 5. This is clearly an irregular section.

The variation of the compass reported by the government surveyor earlier in this field book is 7 degrees 29 minutes east, yet the directions observed for the claim boundary line are reported in increments of one-quarter of a degree. This inconsistency of precision may indicate that the instrument and personnel used to measure the magnetic variation were not the same as those used to measure this particular line.

Later recovery of the line (reported as bearing north $26^1/_2$ degrees east) showed the actual geodetic bearing at this point to be north 25 degrees 32 minutes 14 seconds east (plus or minus 5 seconds). This difference of only 1 degree between the 1872 magnetically based observation and the modern (1985) geodetic direction for the same line is well within the range of reasonably expected values. Depending upon regional factors, the variation between the historic values and the more precisely determined values could be in excess of a degree or more.

According to these notes, the line intersected the northern boundary of the township at a point 24.81 chains along the line and 3.53 chains east of the township corner. A post was set to monument this intersection, and two bearing trees were reported. The first bearing tree is a 4-inch diameter live oak, $10^1/_2$ links away at a bearing of south $78^3/_4$ west. The second is a 5-inch diameter ash, $30^1/_2$ links away at a bearing of north $12^1/_2$ degrees west. The post and the trees are the monumentation of this particular point in the form of corner monumentation and accessories.

10.6.4. Passing Calls

At 42.30 chains along this line, the government surveyor encountered a canal "at its intersection with the Delaronde canal." These reports of features encountered along a line are referred to as "passing calls." This particular passing call is important, because both canals may remain long after the post and trees that monument the last point are gone. Passing calls, when contradictory to recovered corner monumentation, will to yield to the corner and its accessories as proof of the location of a corner. This is only logical. Witnesses to an act who are nearest the action will carry more credibility than someone who is far away.

The art of recovering witness trees is highly refined in certain regions. Even a pattern of three or more stump holes that match the bearing and distances of the original witness trees is considered strong, if not conclusive, evidence of corner recovery.

Unfortunately, in many areas, the activities of nature and human beings have erased all evidence of an original corner. This does not necessarily mean that the corner is "lost." Although the government surveyor's notes recount the features that were geographically near the corner, other notes, survey plats, and events in the chain of title contain information that may be chronologically near the setting of the corner.

10.6.5. Perpetuated Corner

A section corner may be perpetuated through a chain of events leading up to features that remain at the time of a recovery attempt.

For example, let us assume that a section corner and accessories are established in 1835. In 1898, a private Land Surveyor, failing to find the original post, recovers the accessories and remonuments the section corner, according to the GLO notes, with an iron bar.

In 1925, a private survey plat is made that notes the iron bar and several brick buildings, and shows several dimensions that relate the location of the buildings to the iron bar.

In 1988, all that remains are the foundations of several of the buildings. These buildings have become, through perpetuation, accessories that monument the location of the original corner.

Corners that are reset by the discovery of a documented chain of evidence linking existing monumentation to the original monumentation by the government surveyor are called "perpetuated corners."

10.6.6. Corner by Common Report

It may be that the trail of evidence leading from the government surveyor's monumentation to the modern monumentation of a section corner is incomplete.

A monument may have been accepted by an entire community as an original section corner without the documentation necessary to justify labeling it as a perpetuated corner. This acceptance by the community may be so complete that all of the aliquot parts created in each of the contiguous sections hinge on that particular monument. If any alternate location for the comer were to be asserted, the whole community would be thrown into confusion.

It is for this reason that, in the absence of better evidence, such monumentation may be accepted as marking the corner. This is known as a "corner by common report."

10.6.7. Corner Reset by Best Evidence

The most common type of corner or boundary recovery made by the Land Surveyor is based upon a location of a corner by the best available evidence. Passing calls, the relationship to other corners, evidence to the location of the corner not found in the government survey notes, and other sources of evidence often are sufficient to reset a monument at a corner location with certainty that the remonumentation is at the same location as the original corner.

10.6.8. Corner Reset by Proportionate Measurement

Finally, if *absolutely no creditable evidence remains* of the original location of a section corner, certain USPLS rules can be applied to "reset" the missing corner.

Unfortunately, these rules, known as "restoration by proportionate measurement," are widely published by the U.S. government as well as possibly every book on surveying ever published, except this one. The word *unfortunately* is used, because the promotion of the rules governing the restoration of lost corners has encouraged many Land Surveyors to resort improperly to proportionate measurement long before they have exhausted all of the possible sources of evidence.[1]

The recovery of the original section and quarter corners may not constitute a recovery of the boundaries or even assist in that recovery if actions took place, without regard to the sections or their aliquot parts, that reestablished the property boundaries. If a boundary agreement or subdivision of the land took place without reliance on the original section corners, or if a boundary was established by adjudication, then the section lines remain but *cease to be boundary lines*.

10.7. METES AND BOUNDS BOUNDARY RECOVERY

The recovery of property boundary lines under the metes and bounds system of land identification varies from that of the USPLS in a few subtle but important ways. Although section corners in the USPLS can never move, the boundary corners of the metes and bounds system are subject to change.

[1]Division of Cadastral Survey, Bureau of Land Management, U.S. Department of the Interior, Stock Number 024-011-00012-7, *Restoration of Lost or Obliterated Corners and Subdivision of Sections—A Guide for Surveyors,* 1979.

Because the monuments involved mark only boundary corners of contiguous lands and do not have the dual purpose of serving as control for other parcels, the adjoining owners are free to move or reestablish their common boundary lines. Boundary agreements, both formal and implied, as well as adjudication, can and will define new locations for property corners.

The paper trail from the present to the original parcel will still be present in the metes and bounds system, but the formal notes, regimented monumentation, and consistent use of accessories at each boundary corner are often absent. This places more reliance on old survey plats and descriptions than does the USPLS recovery.

The parcels created under the metes and bounds system are not aliquot parts of the parent tract. The chronology of the creation and selling of divisions of a parcel become very important. In this system, the intentions of the parties to a division and sale of land parcels are not based on a regimented procedure; rather, each division is a unique, individual act. Often, it is quite difficult to decipher the true intent of the parties. These, as well as other complications, makes the recovery of boundaries in the metes and bounds system a true art form.

The same rules of evidence apply as in any boundary recovery. Generally speaking, the closer an object is, chronologically and geographically, to an original boundary corner, the more creditable that object is as a source of evidence to the location of the original corner.

Old maps, plats, descriptions, and accounts, both recorded and unrecorded, may produce evidence pertinent to the recovery of a corner. Corners may be recovered, reset by best evidence, accepted by common report, perpetuated, or reset by proportional measurement, just as in USPLS corner recovery.

10.8. PLATTED SUBDIVISION BOUNDARY RECOVERY

Modern platted subdivisions present the simplest cases of boundary recovery. The requirements of most municipalities or local governments for the development and recordation of subdivisions produce well monumented, clearly defined parcels with typically slight discrepancies between recorded dimensions and measured dimensions. Subdivisions that are well settled and well monumented, and that have clearly delineated boundaries rarely produce boundary conflicts.

Older subdivisions or subdivisions that were not settled and occupied may harbor discrepancies that will become evident only after an attempt has been made to posses several lots of the subdivision.

The recovery of boundaries in subdivisions must begin with the limits of the subdivision block or lot involved. This recovery typically, but not always, involves public street rights-of-way. How much of the block is under physical possession (fences, houses, roadways, etc.) is of great importance to the recovery of lot boundaries. Rarely will any Land Surveyor venture beyond block corners to verify boundary locations if the possession lines are in agreement with the deed dimensions.

The metes and bounds description that accompanies many deeds to lots in platted subdivisions will be considered by most Land Surveyors as a supplement to the recorded plat. Discrepancies between the recorded plat and the metes and bounds supplemental description generally will be settled in favor of the platted data, unless it can be shown to be geometrically absurd.

Just as with all boundary recovery, metes and bounds corners can be recovered by finding the monument set by the original Land Surveyor, recovery of perpetuated monumentation, reset by best evidence, accepted by common report, or reset by proportionate measurement.

CHAPTER 11

EVALUATING SURVEY PLATS

Most of the preceding chapters have dealt, in a broad way, with the history and methods of boundary control and boundary recovery. Boundary recovery is the responsibility of the Professional Land Surveyor. The general information given so far will enable the reader to examine, evaluate, and use survey plats better. As in any profession, the ability, training, and competence of individual Land Surveyors will vary. Even the best and most competent Land Surveyors will occasionally make a mistake, miss a judgment call, or simply overlook something. Never assume that the Land Surveyor is always correct. Each survey plat should be examined carefully for discrepancies or inconsistencies. The following checklist is designed to assist the reader in such an evaluation. Each of the items in the list will be explained in detail.

11.1. PLAT EVALUATION CHECKLIST

1. Determine the land record system used.
2. Determine the map projection used.
3. Evaluate the age of the survey.
4. Determine the purpose of the survey.
5. Examine the survey plat for gross discrepancies and completeness.
   a. North arrow and bearing base.

  b. Legal description.
  c. Date of the survey.
  d. Name and address of the Land Surveyor.
  e. Signature and seal of the Land Surveyor.
  f. Adjoining properties.
  g. Dimensions of all sides of the property.
  h. Bearings of all sides or angles at each corner.
  i. Name of the client or purpose of the survey.
  j. Certification.
  k. Limiting notes or phrases.
  l. Area
  m. Scale.
6. Compare the survey plat with the deed for consistency.
7. Examine the survey plat for indications of easements.
8. Examine the survey plat for indications of encroachments.
9. Determine the level of precision.
10. Determine needs not covered in the plat.
11. Contact the Land Surveyor to discuss any excessive discrepancies or additional requirements.

11.2. DETERMINING THE LAND RECORD SYSTEM USED

It is not enough to know if the parcel in question is located in a metes and bounds state or in a USPLS state in order to determine the land record system that was used to create a particular parcel.

A platted subdivision may exist in any state. A metes and bounds division of a tract of land may be disguised as a platted subdivision by the seller's use of "lot numbers" in the sales. A reference to a portion of a section may refer to something other than an aliquot division, according to USPLS rules. Both platted subdivisions and USPLS parcels may have a metes and bounds description included in the deed as a supplement to the legal description.

The importance of the differences between the various systems is only realized when the actual dimensions and locations of real property boundaries of a particular parcel are substantially different from the information found in the deed. The procedure for rectifying such discrepancies will vary according to the land record system used.

Lots created in a platted subdivision do not follow the same rules as lots that developed sequentially in a metes and bounds system. The words *south half* in a USPLS area mean something quite different from those same words in a metes and bounds system.

11.2.1. Recognizing a Metes and Bounds Description

The key to recognizing a metes and bounds controlled description is the lack of direct reference to the control principles of either of the other systems. Even if a parcel is located in a USPLS section and the section number, township, range, and principal meridian are a part of the deed, the parcel may still be a metes and bounds division of a USPLS section. Similarly, the presence of a lot number and subdivision name does not necessarily eliminate the possibility that a metes and bounds system is the controlling land record system at work in a particular situation.

Figure 11.1 is an example of a metes and bounds division of a USPLS regular Section. The Frank James property can only be described by a metes and bounds definition. This particular situation assumes that the line between sections 5 and 8 and the real property boundary line between P. Short and R. McInnis are the same. The line between P. Short and W. Bonney (720 feet east of the section corner) may be one-quarter of the distance to the quarter corner (a $^1/_{64}$ corner is ideally 660 feet east of the section corner). The description of this parcel may identify it as a portion of the NW $^1/_4$ of section 8, and so on. Even if the bounds called for are section lines for certain sides, the departure from the USPLS recognized method of division causes this to be a metes and bounds described parcel.

If the parties that created the parcel shown as the "Frank James" property intend for it to be bounded by R. McInnis, W. Bonney, and P. Short, it is important that the real property boundary lines be stressed in the metes and bounds description. If only the section line or the $^1/_{64}$ line is called for in the metes and bounds description, confusion may result if the section and $^1/_{64}$ lines are later found to be separate from the real property ownership boundaries.

The series of subdivision plats shown in Figure 11.2 indicate that the original owner of the Smith estate sequentially created and sold portions of the property up to May 1, 1932. The deed to each of the lots contains a reference to the lot number, as well as a metes and bounds description. The fact that the May 1, 1932, survey plat is a recorded document does not cause the various titles created from June 3, 1911, to May 1, 1932, to be anything other than a metes and bounds controlled description. The titles for each lot were created at different

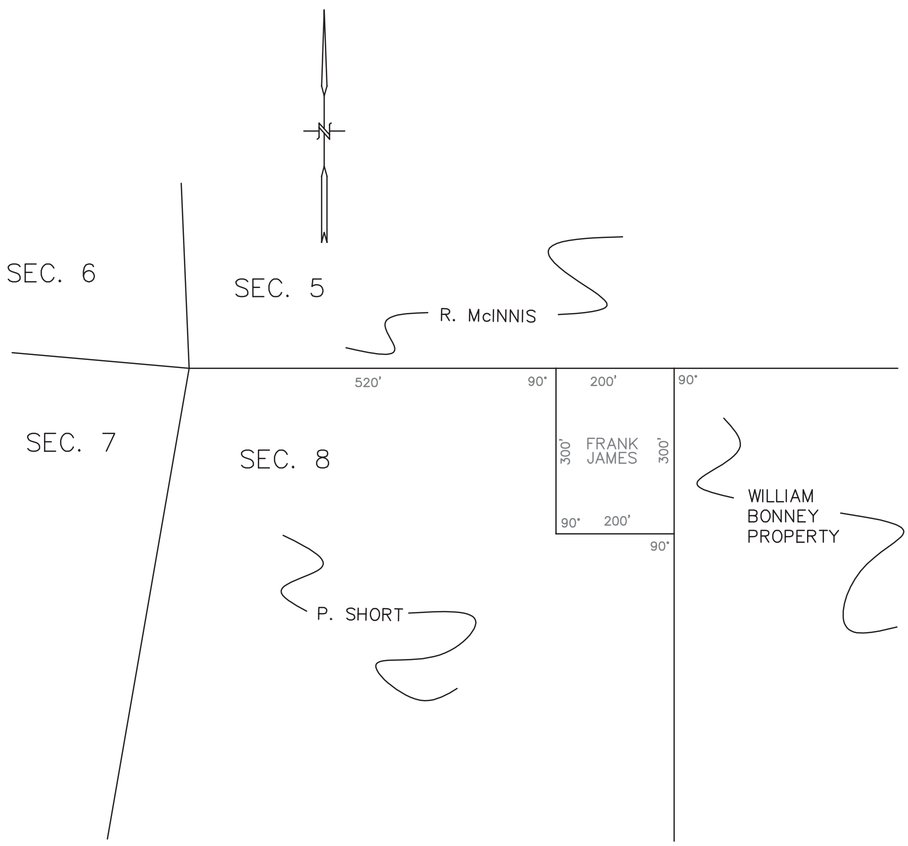


FIGURE 11.1

times, and a precise chronology of that creation can be proven. In order for the division to be considered a platted subdivision, the May 1, 1932, plat must have been created and recorded *before* any of the lots were sold.

If, however, the June 3, 1911, plat had numbered that portion identified as the "Remainder of Smith Estate" as lot number 2, then this would constitute a platted subdivision. The significance of the difference would only be brought to light if the original Smith estate were not 900 feet wide, as the June 3, 1911, survey states it is. If the June 3, 1911, plat were a platted subdivision, then lot 1 and lot 2 would share proportionally the shortages (possession to the contrary excepted).

If the original Smith estate were 850 feet wide, for instance, then the sequence of events portrayed in Figure 11.2 would result in lot 4 being only 200 feet wide.

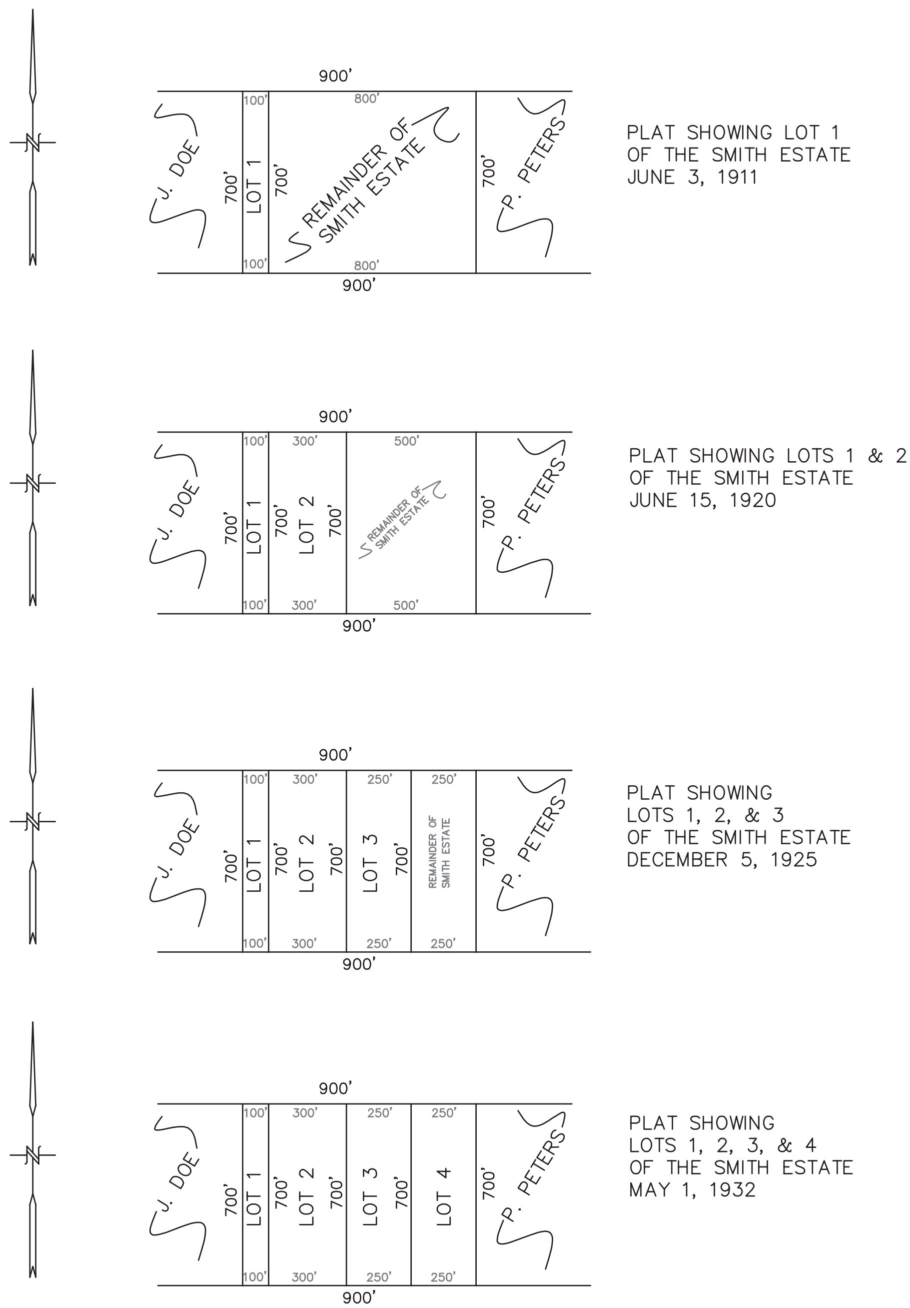

PLAT SHOWING LOT 1
OF THE SMITH ESTATE
JUNE 3, 1911
PLAT SHOWING LOTS 1 & 2
OF THE SMITH ESTATE
JUNE 15, 1920
PLAT SHOWING
LOTS 1, 2, & 3
OF THE SMITH ESTATE
DECEMBER 5, 1925
PLAT SHOWING
LOTS 1, 2, 3, & 4
OF THE SMITH ESTATE
MAY 1, 1932
J. DOE
P. PETERS
LOT 1
LOT 2
LOT 3
LOT 4
REMAINDER OF SMITH ESTATE
900'
800'
700'
500'
300'
250'
100'

FIGURE 11.2

The description of lot 4 would call for the boundary on the east to be that of the western line of the P. Peters property and the boundary on the west to be the eastern line of lot 3. Because lot 3 existed long before lot 4 was created, then lot 3 must be granted all of the width called for, even though the remainder of the Smith estate was not 250 feet wide, as it was believed to be. These subtle nuances, interpreting intent, rely heavily on the system of identifying parcels. For this reason, it is quite important that the system in effect be properly identified.

11.2.2. Recognizing a USPLS

The use of the USPLS must include, as a minimum, the section number, the township number and quadrant, the range number and quadrant, and the principal meridian. In some cases, the principal meridian may not be necessary if the state and county are reported *and* the state or county is served by only one principal meridian. Divisions of sections into smaller parcels must be USPLS lots, in the case of irregular or fractional sections, or must be created by the application of the rules of division governing the aliquot parts of a section.

Divisions of a USPLS section, regular or not, that do not conform to the USPLS regulations must be by platted subdivision or metes and bounds. Division of a USPLS lot is not provided for in the regulations. Sections, or their aliquot parts, must be divided by halves or quarters, based on the *actual length of the sides*, not the theoretical length of the "ideal section." Special rules apply for irregular or fractional sections.

Divisions that are based on the intention to transfer a specific area of land cannot be based on the USPLS rules for the division of a section. A call for one-half of a section is not a transfer based upon a specific area. Because sections are never square, the phrases "south half of the acreage," "south 320 acres," and "S$^1/_2$" all have different meanings. Only the call for the "S$^1/_2$" is a USPLS division.

11.2.3. Recognizing Platted Subdivisions

Naturally, before the rules governing platted subdivisions can apply, a platted subdivision must have been created by someone. It is not absolutely necessary that the platted subdivision be recorded in the public records for it to be valid. It is not even necessary that *all* of the regulatory steps required by the local governing authority be complied with for the platted subdivision to be valid. The determination of the validity of a platted subdivision is a matter of law, and discussion of it is beyond the scope of this book. All of the following discussions about a platted subdivision will assume validity.

In order for a parcel to exist under the platted subdivision system, that parcel must have a unique identifying label. This usually takes the form of a lot “number” or “letter.” Lots may also be called “parcels,” “plots,” or “tracts,” among other things. The distinguishing feature that denotes a platted subdivision is the creation of two are more parcels of specific size from one or more existing parcels *where the division is based on a drawing of the parent tract*. The drawing may be the result of a boundary survey conducted at the time of the creation of the subdivision or simply lines drawn on an old map.

Divisions that intend to transfer parcels based on the location of distinctive terrain features are metes and bounds transfers, even if a plat is produced to assist in the transaction. Divisions that adhere to the requirements of the USPLS are not platted subdivisions, even if a survey and a plat are produced and recorded for the parties involved.

The use of a subdivision “name” is quite common, especially in instances in which a large number of lots are involved. The use of squares or blocks is also common but not necessary. The creation of new streets or public rights-of-way is also a common feature of the platted subdivision of a parcel of land. Modern platted subdivisions are usually easily identified because of the many requirements placed on the subdivider by the local governing authority.

11.3. DETERMINING THE MAP PROJECTION USED

The map projection used will have significant relevance to the degree of precision that may be reasonably expected of the information found on a particular survey plat or map. Directions, for example, are exceptionally sensitive to the distortions inherent in the tangent plane projection—so much so that bearings reported on plats using this projection system cannot be reliably compared with plats of adjacent tracts or even other plats of the same property.

11.3.1. Recognizing a Projectionless System

All projection systems commonly used in survey plats require that the bearings shown be based on *angles measured* at the intersection of land lines. Maps that report bearings of the boundary lines as *independently observed magnetic or astronomic directions* are rarely based upon any projection system at all. The most common example of a "projectionless" map is the U.S. government township plat. These plats are simply a graphic rendition of the government surveyor's notes. Each bearing of each line is an independently observed direction (usually magnetic and "corrected" to "true north").

These directions are not two-dimensional; therefore, the novice will easily be misled. Land lines are defined as "straight" between corners, but all of the intricacies described in Chapter 5 apply. Surveys that were performed by "running" the boundary lines with a compass are usually "projectionless" surveys. The distances and directions of such surveys are typically of the lowest order of precision. This is not to say that these survey plats are without value. It may be that the value of the land being surveyed or the purpose of the survey (e.g., cutting of timber) may not warrant the higher cost of more precise surveys.

11.3.2. Recognizing a Tangent Plane Projection System

Tangent plane projection plats are the most common form of survey plats. The earmark of this type of plat is the use of a general reference to a meridian. Notes on the plat that state that the directions are based on "true north" or some other meridian are strong indications that the map is a tangent plane projection. Notes that state that the directions are based on the reported bearing of a recovered line almost exclusively indicate tangent plane projections.

Plats of very small parcels, such as urban or suburban lots, are often tangent plane projections. In the case of a platted subdivision, the directions shown on the plats of individual lots are frequently based on the same projection system as the subdivision plat. In these cases, the directions shown on each lot plat should be consistent with similar plats of other lots in that same subdivision.

11.3.3. Recognizing a State Plane Projection System

State plane projection plats almost always state on the face of the plat that the directions are "state plane" or "based upon grid north." The appearance of state plane coordinates (SPCs) in the form of "x" and "y" values indicates a state plane projection. The SPC that is appropriate for use in an area is typically established by an act of the legislature of each state.

Prior to 1983, all state plane projections were based on the North American Datum of 1927 (NAD 27). After 1983, a new datum was introduced by NGS to replace NAD 27. This new datum is known as the North American Datum of 1983 (NAD 83). During a transitional period, maps or plats may have been based on either NAD 27 or the new NAD 83. After the end of the transition period, only NAD 83 will be allowed. The implementation of NAD 83 is individually legislated in each state.

Today, NAD 27 is no longer maintained by the federal government, and its use in modern surveys is unwise. Computer programs that translate between NAD 27 to NAD 83 are available, but those translations are somewhat *imprecise*. The many distortions in the NAD 27 network were not entirely modeled in the translation programs. A translation program may produce values to the thousandths of a foot, but in reality the translations may be off a foot or more depending on the source of the original NAD 27 value.

11.4. EVALUATING THE AGE OF THE SURVEY

It is vital that the survey data that is being relied upon is the result of work that is contemporaneous with the action that is taking place. Evaluating the age of the survey is a little more involved than simply reading the date of the survey plat. The "age" of the survey is also a reference to the methods employed by the Land Surveyor who conducted the work. The precision of the work, and thereby the confidence that can be placed in the accuracy of the results, is directly related to the "age" of the survey. As has been shown, government land surveys are not very precise when compared with the general level of capabilities of the survey profession during the same period. This may also be true of certain Land Surveyors when compared with their peers.

Even late 20th-century work may have been performed using old methods because of some special circumstance. A boundary line "run" by magnetic compass in 1980 is not more precise than one run in 1910. A distance measured using rigidly controlled procedures and a calibrated steel measuring tape in 1920 could be more accurate than a poorly controlled chaining in 1970. A telephone conversation with the Land Surveyor who performed the work is the best way to determine the "age" of the survey. If that is not possible, the general history of survey procedures in the region may be obtained from local Land Surveyors.

Most lending agencies have strict rules regarding the acceptable amount of elapsed time between the survey and the mortgage loan. These agencies have learned, through experience, that changes in the possession and use of the land can be quite rapid. Buildings can be erected or expanded. Fences can announce the commencement of acquisitive possession. There are a host of activities or occurrences that can alter the use and enjoyment (and thereby the title) of real property.

11.5. DETERMINING THE PURPOSE OF THE SURVEY

The mere existence of a survey plat is an indication that a contract, verbal or written, was formed between a Land Surveyor and persons interested in some feature of the parcel involved. *If you did not request the survey, the possibility that the Land Surveyor performed the work you want is very small.*

The variety and degrees of complexity in land surveys are such that many of the particular items of interest to you, such as easements or flood hazard, may not have been reviewed by the Land Surveyor, because the person who requested the work was not concerned about those particular details.

If the survey plat being reviewed was not ordered for the specific purpose to which it is being applied, then the survey information on that plat must not be important to the users. If a specific reason for the performance of a survey exists, the Land Surveyor must be completely aware of that purpose so that she or he may tailor the work to suit the needs given. Often, items that are of particular concern are not discoverable by a survey alone.

11.5.1. Land Title Surveys

Surveys that are part of a title examination for the purpose of a change in ownership of a parcel of land require coordination between the Land Surveyor and the title attorney. These particular surveys are known as "land title surveys."

To avoid confusion over the shared responsibilities in a land title survey, the American Land Title Association (ALTA) and the National Society of Professional Surveyors (NSPS), a member organization of the American Congress on Surveying and Mapping (ACSM), have jointly established and published the criteria for land title surveys. Called "Minimum Standard Detail Requirements for ALTA/ACSM Land Title Surveys", the publication is revised from time to time to reflect changes in technology and law. Most state regulatory authorities have also adopted similar standards. In many cases, these standards reflect many of the points or edicts of the ALTA/ACSM publication.

Title attorneys will often request "ALTA surveys" out of habit and tradition. ALTA/ACSM contracted surveys are very specific and well thought-out. Certifications, actions, division of responsibility, and standards are spelled out. Persons requesting "ALTA surveys" are well advised to obtain *the most current version* of the document *and read it!*

11.6. EXAMINING THE SURVEY FOR GROSS DISCREPANCIES

The surveying profession must recruit from the human race. This severe limitation means that Land Surveyors are fallible and may, from time to time, omit vital information or miss obvious discrepancies on the face of a survey plat or within a report. The most difficult blunders to detect in the survey profession occur during the final printing or typing of a survey plat or report.

Examine every survey plat with a critical eye. Take special joy in detecting spelling errors, misprints, obvious omissions, or the transposition of numbers or letters. Distances or bearings that don't seem possible deserve an immediate response from the Land Surveyor. If the discrepancy is the result of a refinement or a correction of a former value, the Land Surveyor will tell you. Most of the items listed in this category are self-explanatory.

11.7. NORTH ARROW

The north arrow shown on a survey plat serves a twofold purpose. Primarily, the north arrow serves the purpose of orienting the plat. The north arrow also serves as an indicator of the bearing base used by the Land Surveyor in conducting his or her work. Changes in bearing base or the use of an imprecise meridian will be reflected in changes in the values presented for the directions of lines. These changes are not relocations of the lines, just an assignment of new values. The absence of a north arrow makes the development of a metes and bounds description quite difficult.

Considered by most Land Surveyors as an essential item on any survey plat, the absence of a north arrow is sometimes common in cases of surveys in very dense, urban areas. If the survey plat that you are using lacks a north arrow and you feel that it needs to be shown, call the Land Surveyor and have it added.

11.8. LEGAL DESCRIPTION

Depending on the land record system in use, the survey plat must show the information necessary to identify the parcel. This does not mean that the complete verbiage of a proper metes and bounds description should be shown on the face of a survey plat in a metes and bounds land records system. A general or abbreviated version of the description will suffice to identify the parcel. The words, sketches, and lines drawn on the survey plat itself will complete the identification.

In platted subdivisions and USPLS records systems, the survey plat caption ought to be in the form of lot, square, subdivision name, county and state or aliquot part, section, township, range, principal meridian (may be omitted), county, and state.

Rules and regulations that require that the "legal description" be shown on the face of a survey plat are referring to the land identification requirements of the system in use. Unfortunately, some have interpreted this requirement to mean that a complete metes and bounds description must be printed on the face of every survey plat. The absolute impracticality of this misinterpretation will be better demonstrated in the exercises in writing metes and bound descriptions found in Chapter 13.

11.9. DATE OF THE SURVEY

The date shown on the survey plat serves to "fix in time" the data represented on the plat. Just as a photograph will present images that are locked in time, a survey plat contains the three dimensions of physical space as well as the fourth dimension of time. As survey plats age, the data shown on the plat may become obsolete. Buildings, fences, waterways, and rights in property all may be altered by time. A photograph of a 2-year-old girl may not accurately portray that same person 30 years later. Changes over time are to be expected in land parcels as well.

11.10. NAME OF THE SURVEYOR

Most survey firms produce survey plats that are drawn on standard paper that has the border, company logo, address, and other information already printed on it. It is surprising how many times this can lead to misunderstanding or oversight. In every survey firm, the responsibility for the collection and interpretation of data rests with one person. That person must be a Professional Land Surveyor registered in the state where the land is located. That individual's name must be shown on the survey plat.

Throughout this book, the need for communication between the user of a survey plat and the Land Surveyor who performed the work is stressed. This is possible only if the Land Surveyor is identified and the means of contacting her or him are clearly presented. A map that does not identify an individual as the Land Surveyor responsible for the drawing is not a survey plat.

11.11. SIGNATURE AND SEAL

The signature and seal have a special importance in land surveying. This formal act of "signing" and "sealing" is a warranty by the Land Surveyor that the information presented is the result of investigations, research, and measurements faithfully conducted according to the standards and procedures of the surveying community existing at the time that the survey was conducted.

This is a guarantee that the surveyor *believes* that the information is a reasonably accurate report of the facts. Deliberate misrepresentations, distortions, misleading information, deletion of relevant facts, or fraud are pledged not to be present. This is a commitment of faithful service made to all who may see the plat. *It is not a promise of infallibility*.

11.12. ADJOINING PROPERTIES

The identification of all of the adjoining properties is normally consistent with the land record system used to identify the subject parcel. Metes and bounds plats usually identify the owners of adjacent properties by name. USPLS-based plats often show the entire section, with emphasis on the aliquot part or government lot that is being surveyed. Platted subdivision lots may refer to only the lot numbers of the neighboring lots. Platted subdivisions that consist of squares or blocks, as well as lots, may only refer to the square or block boundaries instead of the lots immediately adjacent to the lot being surveyed. It is also possible that the adjoining lots may be identified by a combination of systems.

In all cases, the property is bounded on all sides by something. Be it a private owner, a public right-of-way, or the international seas, those adjoiners need to be identified on a survey plat.

11.13. DIMENSIONS OF ALL SIDES

The dimensions of all the boundary lines of the parcel surveyed should be shown. If the dimension of a particular side cannot be measured, then an estimate and an explanation for the lack of a measured dimension should be shown. The parameters of the dimensions should be consistent. If the measurements are reported in U.S. survey feet, tenths and hundredths, then all sides should be in U.S. survey feet, tenths and hundredths. If directions are reported by bearings, then the bearings of all sides should be shown.

An exception to this rule occurs in cases in which, for historical reasons or for clarity, dimensions that are reported in the deed record but are no longer in use are shown on the plat, along with the modern measured value. A frequent form of this exception is use of the notations "actual," meaning the dimension measured during the present survey, and "deed" or "title," meaning the recorded or previously reported dimension for that same line segment.

11.14. BEARING OR ANGLES

The bearings shown on a survey plat must also be consistent in both parameters (e.g., degrees, minutes, seconds) and meridian. A bearing shown to the nearest degree should not appear where other bearings are shown to the nearest second. The precision of the measurement implied in the first case is much less than that implied in the latter. For example, a bearing of north 25 degrees east must be shown as "north 25 degrees 00 minutes 00 seconds east" in order to be entirely consistent with a bearing shown elsewhere as "north 27 degrees 15 minutes 33 seconds west." Naturally, presenting bearings in degrees, minutes, and seconds in one place and grads, for instance, in another, is a gross violation of the "consistent parameter" rule.

It is also awkward to define directions of lines by a combination of angles and bearings. Clarity and consistency are best served when one method or another is consistently used throughout a survey plat.

A common historical exception to this general principle is the "implied direction or dimension." Often, particularly subdivisions involving small parcels, lines are parallel or angles are clearly 90 degrees and dimensions are repetitive. In these cases, omission of bearings, angles or dimensions were frequently accepted as minor or unimportant.

Plats of urban or suburban home sites are usually restricted to "legal size" paper ($8^1/_2$" × 14"), thereby limiting the amount of information that can be reasonably shown in such a small space. The use of "implied direction" is one way in which much of the clutter was eliminated from small drawings. Almost all of the modern standard detail requirements promulgated by regulatory authorities prohibit implied directions or dimensions.

11.15. NAME OF CLIENT, PURPOSE OF SURVEY

The name of the person for whom the survey was performed or a particular statement expressing the purpose of the survey can be an important indication of the extent of the work performed. Only the person named on the survey has a reasonable right to expect the survey to report the information that he or she requested.

A survey performed for a particular purpose can only be reasonably used for that purpose. It is foolish to assume that a survey performed at the request of someone else will contain all of the information you want to see. It is equally foolish to assume that a survey performed for one particular purpose will fulfill all of the requirements of an alternate need.

For example, a survey that was performed to confirm compliance with zoning restrictions may show the dimensions of a building that are not adequate for computation of the area of the floor space of that building. Zoning restrictions ignore recessed doorways; floor space computations do not.

11.16. CERTIFICATION

Special attention must be paid to the certification that appears on a survey plat. The phrase "certified correct" that was so popular in the past has been largely dropped by the land surveying profession. This phrase has been found to be much too general and subject to interpretations never dreamed of by Land Surveyors. "Certified correct" means not only that all of the information shown is correct (how accurate must a dimension be to be "correct"?) but also that *all* of the information that the reader desires is shown. This interpretation requires that the Land Surveyor know, at the time a survey is conducted, the needs of some unknown, future user of the survey plat. This is an impossible task to fulfill; consequently, Land Surveyors have begun to *explain*, in the certification statement, as well as in special notes, the extent of work performed and the limits of the warranty promised by that work.

11.17. LIMITING WORDS OR PHRASES

The most pronounced of the recent developments in the relationship between the Professional Land Surveyor and his or her client has been the increased use of words or phrases on survey plats that spell out what was and what was not performed by the Land Surveyor in the development of that plat. This clarification of the duties performed by the Land Surveyor has caused some protest from the users of survey plats who did not realize that the plats that they had been using all along actually had these limitations.

Land Surveyors are not title abstractors. Land Surveyors do not, in the normal course of business, search the deed record or chain of title for easements, restrictions, zoning, or other legal instruments that may affect a parcel of land. Those parties who had incorrectly believed that Land Surveyors were abstracting titles were quite upset when they were informed that the discovery and interpretation of recorded information rests with the legal profession.

The discovery of visible acts, on the ground, that encumber a property, whether recorded or not, is the responsibility of the Land Surveyor. The attorney evaluates the written or legal factors encompassed in the title to real property; the Land Surveyor evaluates the corporeal factors encompassed in the land itself. The combination of these two services constitutes a complete record of a real property parcel.

Statements on the survey that explain the extent of work performed by a Land Surveyor are there to ensure that no one mistakes a survey plat for an abstract of the deed record.

If it is important to the purpose of a particular plat that this information be shown, the Land Surveyor must be presented with such written records as the user desires to be shown. Limiting phrases can be removed if the information not normally searched for by the Land Surveyor is provided. These phrases are as much an integral part of the survey plat as are the bearings and distances, yet it is amazing how many persons, who would never contemplate asking a Land Surveyor to misrepresent a dimension, demand the removal of these important informational phrases.

11.18. AREA

The area of a parcel is based on a computation that involves several sets and combinations of measured values. For this reason, the area called for in a deed or reported in a survey plat holds the lowest ranking in the hierarchy of calls. Sales of property, however, often define the value of a parcel of land in terms of the area. Ironically, the one dimension considered to be the least reliable is often depended upon to set the most important aspect of any parcel of land—its monetary value.

Many Land Surveyors will omit the area of a parcel unless that information is specifically requested by the client. This omission is not critical in most cases of surveys of small, rectangular, urban, or suburban lots in which the computation of the area is obvious or the value of the property is not directly determined by the area. In cases of large or complicated parcels, however, the area is an important part of the information that is relevant to real property parcels.

11.19. SCALE

The scale shown on survey plats represents the relationship of the dimensions on the original plat to the dimensions of the survey. Most modern minimum standard detail requirements call for a statement of the scale and a bar scale on every survey plat.

Often, the survey plats that are handled by clients are *copies or reproductions* of the original drawing. Almost all reproduction processes will result in *distortions* of the plat. Paper will stretch or shrink in reaction to changes in humidity and many other factors. Such changes can have a dramatic impact on the fidelity of the scale on any plat. It is for these reasons that scaling dimensions on a plat are strictly reserved for *estimating* values. If a dimension is important, one should *never* depend on a scaled measurement of that dimension.

In the case of individual residential survey plats, the primary recipient of the plat is a homeowner who is usually unaware of the dangers of scaled values. For this reason, many Land Surveyors deliberately did not report the scale used to produce their plats. Land Surveyors are only too happy to compute or measure dimensions that are of interest to the user of a survey plat.

11.20. COMPARING THE SURVEY PLAT WITH THE DEED

There often are inconsistencies between deed information and survey data. These inconsistencies are, normally, the necessary result of the improved or updated information about a particular parcel of land. The Land Surveyor must make several judgmental decisions during the interpretation of boundary evidence discovered during a survey. It is very common for surveys of small, modern, urban home or business sites to agree exactly in every way with the information shown in the deed. This is because short distances are involved, rigid subdivision codes have been applied, and frequent street rights-of-way prevent the accumulation of small measurement errors into detectable proportions.

It is more common, particularly in cases of less-than-modern work, for the information contained in a deed to be slightly different from the information shown on a survey plat. Corrections to distances are quite common and may be the result of improved measuring techniques, corner interpretation, superior recovery methods, or simply new evidence, among other things.

Directions (bearings) are even more likely to vary from the deed information than are distances. Except in cases of state plane projections, the accumulation of inconsistencies found in adjacent tangent plane projection surveys or the even more pronounced variations of magnetic meridians cause the directions shown on many survey plats to be suitable for little else than computing the angles formed at boundary line intersections.

Variations between state plane directions reported on a deed and state plane directions recovered during a particular survey should reflect only accumulated measurement error. The amount of acceptable variation depends on the level of precision needed. Changes in the state plane projection datum may cause a change in the values associated with the state plane directions (bearings) of boundary lines. The survey plat should report the datum associated with the directions shown.

11.21. EXAMINING THE SURVEY PLAT FOR EASEMENTS

Easements are a nonpossessory interest held by one party in the real property of another whereby the first party is accorded partial use of said property for a specific purpose.[1] These rights that others may have can flow from one of two sources: the easement might be the result of a written agreement or the result of use. Easements may take one of two forms: they may be obvious (apparent), or they may be hidden.

Easements that are obvious, with physical indications of their existence on the ground, will be discovered by the Land Surveyor. Easements that are hidden may not be discovered by the Land Surveyor.

[1] American Congress on Surveying and Mapping and the American Society of Civil Engineers, *Definitions of Surveying and Associated Terms,* 2005 (rev.).

Hidden easements that are written and recorded will be discovered by *a title examination only*.

Land Surveyors do not normally perform complete title examinations unless they are requested to do so by the client. Most Land Surveyors are not in the title insurance business. If you want to have all of the easements or other statutory restrictions associated with a real property parcel shown on a survey plat, *you must inform the Land Surveyor of their existence*.

Title insurance companies are responsible for the majority of survey requests in the United States. Surveys performed for title insurance companies will not duplicate the title research work of the insurer. The Land Surveyor will report all *apparent* easements, some of which may not be discoverable by a title search, and the title insurance company will report all recorded easements, some of which may not be discoverable in the field.

Compare each survey plat with the title records for evidence of hidden, but recorded, easements. If a survey plat does not report an easement that is in the title record, it is wise to inform the Land Surveyor so that he or she may show this information on the survey plat. *Never rely on a survey plat as the absolute and sole source of land title information*. The survey plat is a field report of physical limits and conditions of a real property parcel. Title examinations and opinions are the professional preview of attorneys, not Land Surveyors.

11.22. EXAMINING THE SURVEY PLAT FOR ENCROACHMENTS

Encroachments are physical objects (obstructions) that invade upon the rights of another.[2] Encroachments are evaluated by the degree to which the free use and enjoyment of a real property parcel is affected. Few have any problem with recognizing and evaluating the impact of the encroachment of buildings, walkways, roadways, and other structures normally contained entirely within the boundaries of a designated parcel. The acquisitive act of a building extending across a property line is very clear; this is not so with fences.

11.22.1. Fences and Fence Lines

Fences and fence lines deserve particular discussion here because, unlike all of the other forms of structures mentioned, they are normally

[2] Id.

intended to be “on the boundary.” Boundary land lines are not physical things and, as we have seen, are defined to have a length but not a width.

Fences are very real things and do have width. It is quite impractical to expect a fence to be “on the boundary line” without some portion of the fence being across the boundary line. There is much debate about what is measured when the Land Surveyor is measuring a fence location.

Figure 11.3 is an example of what has been offered by some as a way of interpreting the term *fence line*. This interpretation defines the facing of the fence as that which constitutes the “fence line”. It is the barbed wire, or the chain link, or the 1 × 6 facing, not the supporting fence posts, that obstruct movement across fence lines. Therefore, these obstructions must form the “fence line.” This logical theory has a very fundamental flaw.

Let us assume that a landowner wants to construct a redwood fence on the boundary line between himself and a hostile neighbor. If the definition demonstrated in Figure 11.3 were to apply, then the owner would center the posts four inches from the boundary line (the thickness of the 1 × 6 facing plus the 2 × 4 stringers plus $^{1}/_{2}$ the diameter of the fence posts). Setting the posts and bolting on the stringers can be accomplished without crossing the boundary line. Nailing on the 1 × 6 facing, as well as regular maintenance, would require the owner of the fence to trespass onto the neighbor’s land. Under this definition of “fence line” no one could construct or maintain a fence “on line” without the full and continual cooperation of the adjoiner.

However, if we were to define the fence line as being the centerline of the supporting fence posts, then half of all fence posts would be across the boundary line. There would be land between the boundary line and the facing of the fence that could be maintained only by the neighboring landowner. Complicating this situation is the fact that most fence posts are not perfectly vertical. Where is the fence line in these cases? Should it be at the ground? Should it be at the top of the fence? It is obvious that practicality demands toleration of a certain amount of encroachment, as well as trespass, in order for a boundary fence to exist.

It is for these reasons of practicality that the rigid definition of the location of a “fence line” demonstrated in Figure 11.3 is being replaced by one that defines a fence as being “on line” when any visible part of the fence is on line. Under this “liberal” definition of a fence line, fences may be constructed without continual trespass for maintenance and without the fear that a slight encroachment of facing or post could

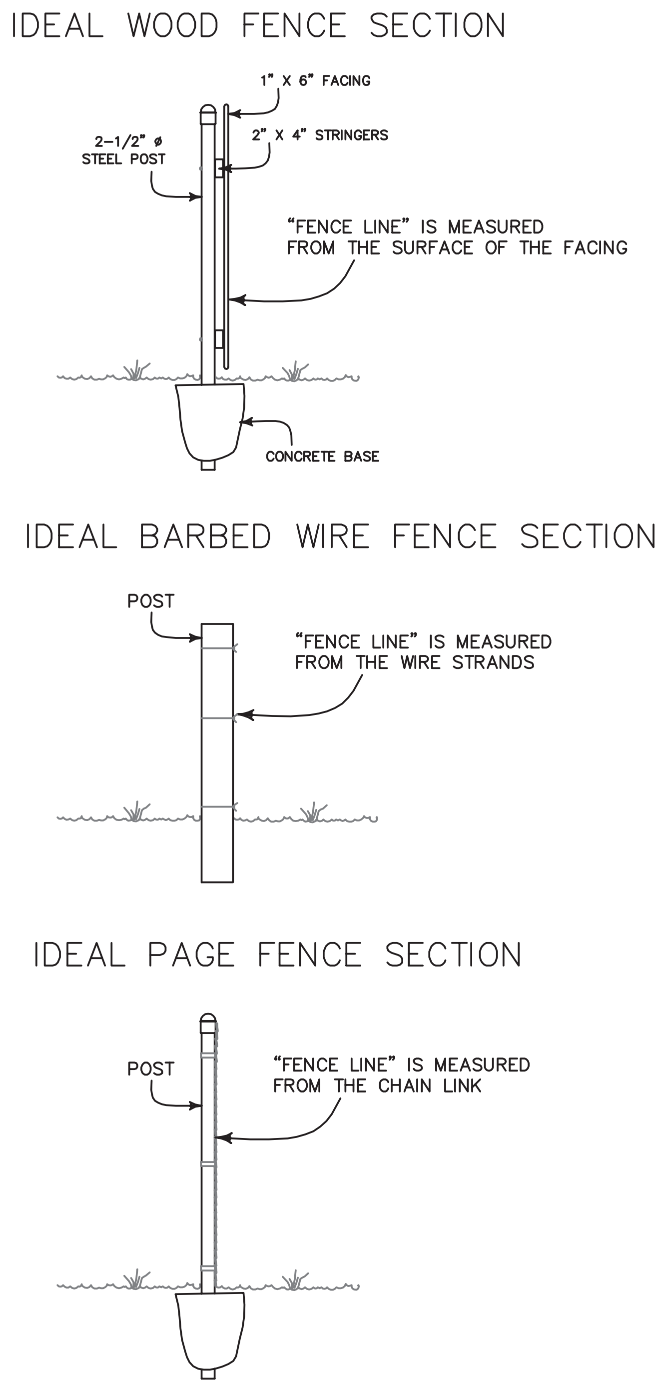

IDEAL WOOD FENCE SECTION
1" X 6" FACING
2" X 4" STRINGERS
2-1/2" ø
STEEL POST
"FENCE LINE" IS MEASURED
FROM THE SURFACE OF THE FACING
CONCRETE BASE
IDEAL BARBED WIRE FENCE SECTION
POST
"FENCE LINE" IS MEASURED
FROM THE WIRE STRANDS
IDEAL PAGE FENCE SECTION
POST
"FENCE LINE" IS MEASURED
FROM THE CHAIN LINK

FIGURE 11.3

be interpreted as an acquisitive act. Each locality may differ in this interpretation, based on regional court decisions.

11.23. DETERMINING THE PRECISION REQUIRED

The ACSM developed a set of classes of surveys based on expected land use. Published as the *Minimum Standard Detail Requirements for ALTA/ACSM Land Title Surveys*, these general classifications have been mirrored, to varying degrees, by many state surveying organizations or regulatory boards. Early versions of this publication also listed several procedural and closure requirements for each class. These requirements are somewhat technical in nature, applicable only during the measurement and computational phases of a survey, and very difficult to assess without field notes or working papers.

Modern revisions of the ALTA/ACSM publication have dropped the "Class of Survey" designations, but most State and local regulators have not.

The ALTA and the National Society of Professional Surveyors (a member organization of the ACSM) has since significantly revised the initial publication and produced the *2005 Minimum Standard Detail Requirements for ALTA/ACSM Land Title Surveys*. The most recent version of the *Minimum Standards* is available on the web site www.acsm.net.

Among the revisions is the adoption of a single *Allowable Relative Positional Accuracy* standard. That standard is "0.07 feet (or 20 mm) +50 ppm." While the deviations quoted are well within the capabilities of the modern Land Surveyor, the vague, inconsistent, and undefined terms contained in the *Allowable Relative Positional Accuracy* are significant, and the publication is certain to be amended further. The concept that "accuracy" rather than "precision" can be predetermined is contrary to reality. The revised publication is not included in this work.

State regulatory authorities may not have amended their rules and regulations to accommodate the changes. Therefore, many aspects of the former regulation need to be discussed even though the 2005 publication has dropped the concept of class of surveys. The list that follows presents the class of surveys, as previously defined by the ACSM publication, as well as this author's interpretation of what the *effect* of the recommended procedure and computational requirements would be. The historical ACSM definition is set within quotation marks.

11.23.1. "Class A. Urban Surveys"

"Surveys of land lying within or adjoining a City or Town, this would also include the surveys of Commercial and Industrial Properties, Condominiums, Townhouses, Apartments, and/or other multi-unit developments, regardless of geographic location."

Generally speaking, the actual relative positions of distinct features within a "Class A" survey may vary from the position published on the plat by a maximum distance obtained by the equation (Variation = 0.03 feet + D/15,000), where "D" is the distance between features. For example, if the distance between two boundary monuments is shown to be 1,347.56 feet on a survey plat, the acceptable variation would be about 0.12 feet (0.03 + 1,347.56/15,000). Therefore, the actual distance between monuments may be anywhere from 1,347.44 feet to 1,347.68 feet and still be within the tolerances of the "Class A" category.

Similarly, the bearings shown on the survey plat have an allowable variation of about 15 seconds (relative to the meridian or bearing base and depending on the length of the line). A published bearing of north 27 degrees 34 minutes 05 seconds east would be within tolerances if the actual bearing were anywhere between north 27 degrees 33 minutes 50 seconds east to north 27 degrees 34 minutes 20 seconds east. This, of course, does not apply when *different bearing bases are used*.

11.23.2. "Class B. Suburban Surveys"

"Surveys of lands lying outside urban areas, this land is used almost exclusively for single family residential use or residential subdivisions."

This is, by far, the most common class of survey. The result of the application of the recommended tolerances for the procedures and computations of the "Class B" survey are positional accuracies or variations of about 0.05 + D/l0,000 feet and directional variations of about 20 seconds. The dimension of 1,347.56 feet given in the previous example would be considered within tolerances of a "Class B" survey if the actual value were anywhere between 1,347.38 feet and 1,347.74 feet. The bearing of north 27 degrees 34 minutes 05 seconds east would be considered within tolerances if the actual bearing (relative to the same base) were anywhere between north 27 degrees 33 minutes 45 seconds east and north 27 degrees 34 minutes 25 seconds east.

11.23.3. "Class C. Rural Surveys"

"Surveys of land such as farms and other undeveloped land outside the suburban areas which may have potential for future development" define Class C Surveys.

The tolerances under "Class C" are about (0.07 + D/7,500) for positions and about 30 seconds for directions. The acceptable range of values for our example dimension of 1,347.56 feet broadens to between 1,347.31 feet and 1,347.81 feet, and the directional range varies between north 27 degrees 33 minutes 35 seconds east and north 27 degrees 34 minutes 35 seconds east.

11.23.4. "Class D. Mountain and Marshland Surveys"

"Surveys of land which normally lie in remote areas with difficult terrain and usually have limited potential for development" constitute Class D Surveys.

The requirements for a "Class D" survey roughly translate into acceptable positional variations of 0.10 + D/5,000 feet and acceptable directional variations of 40 seconds. The acceptable limits of our examples would then be 1,347.19 feet and 1,347.93 feet for position, and north 27 degrees 33 minutes 25 seconds east and north 27 degrees 34 minutes 45 seconds east for directions.

These example variations are not presented as absolute limits but merely as guidelines intended to give the reader a "feel" for the range of reported dimensions that one should reasonably expect for each "class" of survey. Users should evaluate their own tolerance for deviations based on an assessment of the particulars of a given survey. Tolerances more restrictive than "Class A" are possible but prohibitively expensive. An old country surveyor's cliché best remembered when one is deciding on the tolerances required is: "We're measurin' a fence line, not buildin' a violin."

All of the positional tolerances ever presented assume that it is possible to *know* the *true* dimension of a given line. A challenge to a dimension presented on a survey plat will be reduced to comparing the *procedures used* by different Land Surveyors in arriving at a value.

11.24. DETERMINING NEEDS NOT COVERED IN A SURVEY PLAT

Every user of land survey data has his or her particular needs and expectations, as dictated by the purpose of the survey. The list of items in the ALTA/ACSM Minimum Standard Detail Requirements (Appendix A) represents the minimum requirements usually associated with the typical boundary survey. It is very possible that your particular needs will exceed the minimum requirements or be beyond the limits expressed by special notes or the certification.

Chief among the needs not commonly covered by the typical survey plat is the existence and location of all easements or servitudes affecting the parcel. Even in the absence of restrictive words or phrases, it is very wise to ensure the inclusion of recorded easements or servitudes by providing the Land Surveyor with an abstract of the title or, at the very least, by comparing the survey plat with the deed and title information yourself. The Land Surveyor will be delighted to add any information contained in the chain of title, even if it is not apparent on the ground.

11.25. CONTACTING THE SURVEYOR

It is vital that, before using the information found on any survey plat, the user of the information and the developer of that information have a clear and concise agreement on the limits of research and the purpose of the plat. This is not difficult if the survey plat was developed from a direct request by the user. Full communication, at the time the survey is requested, will provide this important link. If the user is not the same person as the one who is ordering the survey, full communication is not possible until the user contacts the Land Surveyor directly.

The user should simply pick up the telephone and call the Land Surveyor who developed the plat. The user should tell the Land Surveyor how the plat is to be used and should ask if the Land Surveyor anticipated that particular use. The user should question the Land Surveyor about *anything* that appears to be odd or unusual.

If the information is correct, the Land Surveyor will happily explain it. If the information cannot be easily explained or is incorrect, the Land Surveyor will gratefully revise the information and send an updated version of the plat or report. Land Surveyors want their work to be reviewed as carefully, as critically, and as often as possible *before* reliance is placed on the information presented. Often, the only critical review possible is in the Land Surveyor's own office. When external critical review is possible, the Land Surveyor welcomes it. The saddest words ever heard, usually after an expensive undertaking, are, "I thought that looked funny!"

Certifications or limiting words and phrases on survey plats that identify the plat as not providing all of the information that is desired do not render the plat useless. Often, the desired information can be added or the limiting phrase reworded if the necessary information is provided to the Land Surveyor. Plats that report that easement information is not shown, for example, may have that limiting phrase removed if the Land Surveyor is provided with all recorded easement information.

It is a great disservice to future users of a survey plat if any Land Surveyor were to remove the limiting words from a survey plat without also eliminating the need for the phrase.

If the Land Surveyor cannot be contacted, it is foolhardy to use any survey plat developed by that Land Surveyor for anything other than a general graphic aid for the parties involved. The Land Surveyors who are active in a particular area can provide insight on the abilities, typical procedure, and reasonable expectations of accuracy of deceased or retired Land Surveyors.

Often, the files of inactive Land Surveyors are sold or given to active local professionals for safekeeping and referral. The state or local professional surveyor's association can be contacted for assistance in locating such files.

CHAPTER 12

EXERCISES IN EVALUATING SURVEY PLATS

The following exercises are designed to clarify the recommended guidelines for evaluating survey plats. These guidelines are very general. Several states have developed, either through their state board of registration or through their professional societies, a minimum standard of practice. Such states may require information in addition to that shown as typical in these example plats.

None of these example plats is presented as an ideal example of a survey plat. All of the examples are drawn from actual cases but are greatly simplified, and appropriate name and location changes have been made. The strengths and weaknesses of each example will be discussed so that the reader may ponder them and apply the thoughts expressed to real survey plats. The numbers and letters in parentheses refer to the checklists mentioned in Chapter 11. Each of the exercises will take the form of a scenario. The reader is not expected to agree completely with each and every step in the scenario. Indeed, part of the learning experience is reflecting on and pondering how the reader may have proceeded differently.

12.1. THE CASE OF THE THREE PARTNERS

Ms. Cazes has the deed to lot 2 of section 11, township 3 north, range 5 west, Walnut County, Nebraska. The deed simply refers to the property as “lot 2, T3S, R5W, Walnut County Nebraska.” Along with the deed,

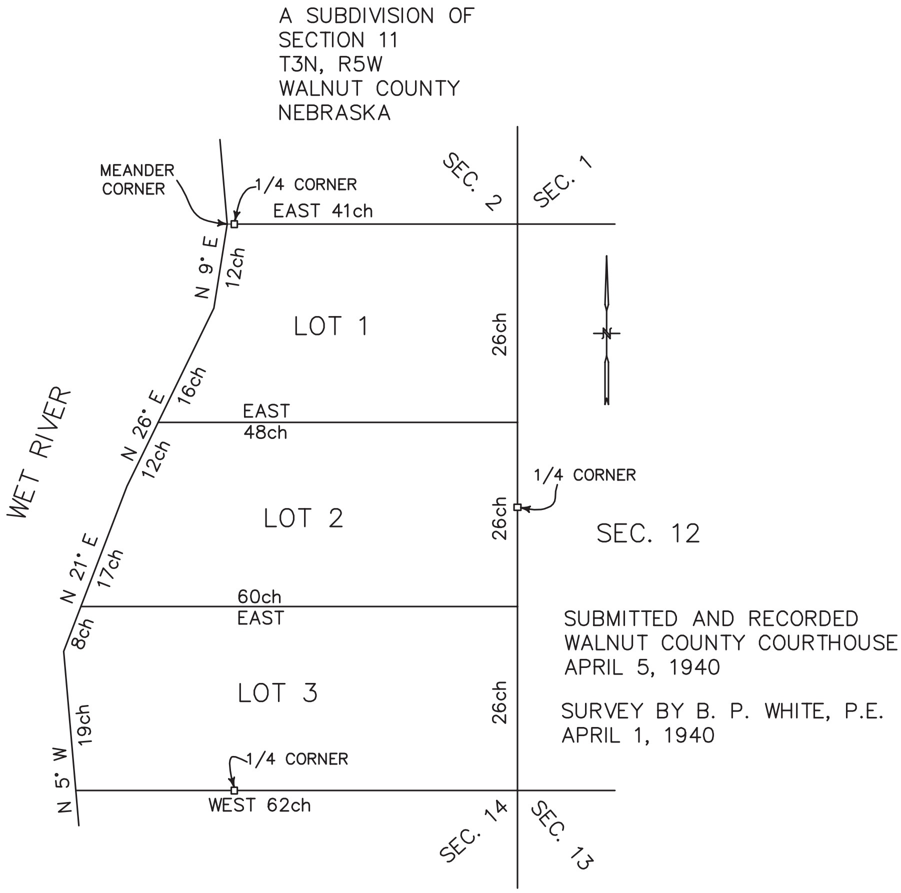


FIGURE 12.1

which she inherited from her father, is the map shown in Figure 12.1. Ms. Cazes's father was one of the original three partners who together owned section 11. The record indicates that the three caused the property to be subdivided and that each received one of the lots.

Ms. Cazes now wishes to sell lot 2. Evaluate the original plat and assess its usefulness in such a sale.

1. The presence of a section, township, or range might cause the reader to think that the controlling land record system here is the USPLS. This is only partly true. If lots 1, 2, and 3 were not formed by the government surveyor or by the application of the USPLS rules, then the lots were formed by a platted subdivision. The exterior boundaries of the subdivision, being the boundaries of section 11, fall under the recovery rules of the USPLS. The

lots do not. The land record system for the individual lots is the platted subdivision system.

2. The use of the cardinal directions, as well as the fact that all directions are reported to the nearest degree, suggest that the bearing of each line was independently observed. This is a projectionless map. The plat is simply a drawing of the directions and distances observed for each line.
3. The date indicates that the work was done in 1940. All distances are rounded off to the nearest chain (66 feet) in all directions, to the nearest degree. This indicates a crudeness of measurement that is more typical of 1840 than 1940.
4. The purpose of the survey is obviously to document a division of the section into three lots. The dimensions at the east boundary indicate a desire to divide the lots by near equal division of this side.
5. a. The north arrow is shown with no reference to a bearing base. The crudeness of the values suggests that a magnetic compass was used, and it is very unlikely that a resurvey of any of the lots will duplicate the directions reported on the subdivision plat.
   b. The legal description of any of the lots is "lot——of the subdivision of section 11, T3N; R5W, Walnut County, Nebraska, recorded April 5, 1940" and is shown on the survey plat. The absence of a reference to a principal meridian will not be of any consequence if only one principal meridian serves all of Walnut County.
   c. The date of the survey is shown, along with the recordation date. This must be verified by examining the records.
   d. The name of the "Land Surveyor" is shown, but not the address.
   e. The survey plat is not signed or sealed, but the age of the document indicates that it probably followed the accepted procedure for a subdivision of land at that time and, if recorded, will probably defeat any attempt to refute its authenticity.
   f. All adjoiners are shown by section numbers or as the Wet River. If the Wet River were navigable at the time of the original government survey, this would be a riparian boundary.
   g. All dimensions are shown and are unusually even. The dimension of 80 chains for the east boundary of the subdivision is particularly suspicious.

h. The bearings of all sides are shown, and they, too, are suspiciously close to the directions typically called for in the government surveys.
i. The name of the client is absent, but the purpose of the survey is obviously to document the creation of three lots.
j. There is no certification statement.
k. There are no limiting words or phrases. The drawing is one of such little detail that one could reasonably expect that buildings, fences, driveways, and other features exist but are not shown.
l. The area is not shown.
m. The scale of the drawing is not shown.

6. A comparison with the deed is consistent with the plat. The deed does not contain a metes and bounds supplementary description. The original government township plat of T3N, R5W, dated 1866, reports the exact same bearings and distances for the exterior of section 11 as does the subdivision plat.
7. There are no easements shown, but, considering the age of the plat, this is not surprising.
8. No improvements are shown at all. This may be an indication that the improvements were present but deemed unimportant or that the land may actually have been vacant.
9. The accuracy standards, as indicated by the dimensions shown, are so crude as to fall below any of the modern "classes" of surveys.
10. There is a wealth of information that is not addressed that would be of importance in a sale of this property. The deed record must be reviewed (title examination) for recorded easements, rights-of-way, possible partitions, and so on. Buildings, bounding fence lines, corner monumentation, and other physical features need to be examined. Clearly, this parcel must be resurveyed, and an abstract of the title record must be made prior to any sale. As with any purchase of real property, a title insurance policy is a must.
11. After attempts have been made to contact B. P. White, it is discovered that he is deceased.

12.1.1. Conclusion

The fact that the bearings and distances reported for section 11 by the government surveyor and those reported by B. P. White for the exterior of the subdivision of section 11 are exactly the same is conclusive proof that White did not resurvey or recover the boundaries of section 11 prior to the drafting of the subdivision plat. It is highly probable that White simply drafted the subdivision from the government plat and never even visited the property. This is a "paper survey" and serves no other purpose than to indicate the intended division of the section. Lot 2 must be resurveyed by recovering as many of the original section, quarter, and meander corners as possible.

A survey of lot 2, section 11, T3N, R5W, Walnut County, Nebraska, was ordered, and Figure 12.2 is a copy of the resulting survey plat.

By applying the same examination procedure as before, we can discover the following information:

1. The external boundaries of Section 11 are reported by J. Ford as being recovered. The distance between the NE corner of section 11 and the east $^1/_4$ corner is only 6.7 feet less than the original government survey's 40 chains (2,640 feet). The distance between the SE corner of section 11 and the east $^1/_4$ corner is 41.39 feet less than 40 chains. The line between the NE and SE corners of section 11 is not a straight line. All of these signs indicate a recovery of the east line of section 11 based on a proper recovery of the corners.
2. The presence of an "x" and "y" at the NE corner of section 11, as well as the note "Grid Bearings NAD 27" indicate that the state plane projection system for Nebraska is being used. Ford's references could be elaborated in order to define better the projection system used. Nebraska law may require special wording or notes when state plane coordinates (SPCs) are being used.
3. The survey plat indicates directions and distances that are defined to a second of an arch and to a hundredth of a foot.
4. Because we requested the survey, the purpose is known. When the survey was requested, a full explanation of the purpose and expected use of the survey was made to Ford.
5. a. The north arrow and bearing base are shown.
   b. The legal description "lot 2 of section 11, T3N, R5W, 6th P.M. Walnut County, Nebraska" is shown on the survey plat.
   c. The plat is dated "January 18, 1987."
   d. The name and address of the Land Surveyor is shown.
   e. The plat is signed and sealed.

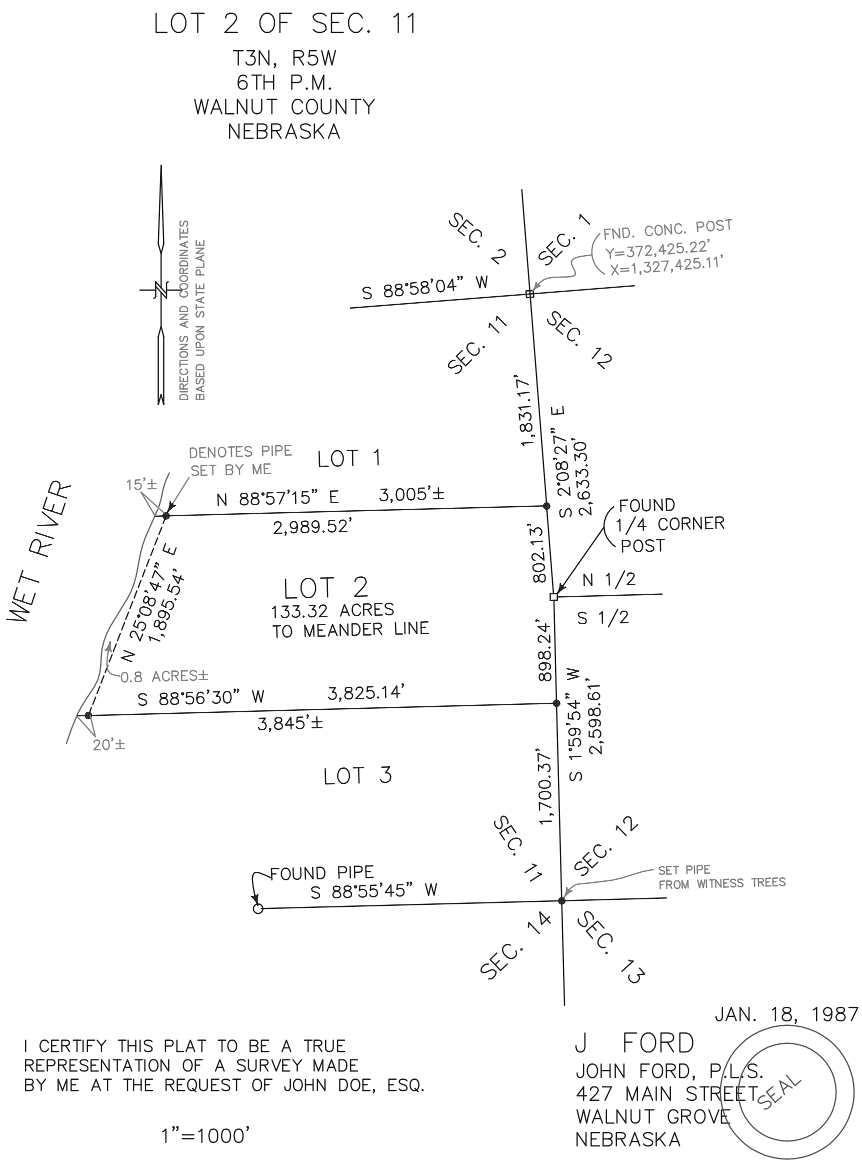


FIGURE 12.2

f. The adjoining properties are shown by lot number, natural feature, or by USPLS designation as applicable.

g. All dimensions of all sides are shown. The north line of lot 2 shows a total length of 3,005 feet, *plus or minus*, meaning "more or less." This is appropriate because of the indefinite nature of riverbanks. This distance is shown on the subdivision plat as 48 chains (3,168 feet). The distance between the NE corner of lot 2 and the NW meander corner of lot 2 is shown as 2,989.52 feet. The distance from the meander corner to the Wet River is shown as 15 feet, *plus or minus*. The sum of these two distances is 3,004.52 feet. This is consistent with the shown total of 3,005 feet, plus or minus. It would be scientifically incorrect to express the distance as "3,004.52 feet, plus or minus," because this would imply that the magnitude of the uncertainty was in fractions of a foot, whereas the plat clearly expresses the magnitude of uncertainty in feet (15 feet, plus or minus). Similarly, 20 feet, plus or minus, added to 3,825.14 feet is consistent with the total 3,845 feet, plus or minus. The subdivision plat reports this second distance as 62 chains (4,092 feet).

h. The bearings of all lines, including the new meander line (north 25 degrees 08 minutes 47 seconds east), are shown. The fact that the bearings are expressed to the nearest second suggests that a high degree of precision may be accorded to these values.

i. The name of the client is shown. The purpose of the survey is not stated.

j. The certification states that the information shown on the survey plat accurately reflects the results of the survey performed by Ford. It does not claim that the survey was performed to any particular standard, nor does it warrant any of the information as "correct."

k. There are no limiting words or phrases on the face of the plat.

l. The area is shown to be 133.32 acres to the meander line. This means that the strip of land between the meander line and the Wet River is not included in the acreage figure shown. This meander line is a new line established by Ford and is not to be confused with a boundary line or the original meander line by the government surveyor.

m. The scale is shown as "1" = 1,000'." This may be checked by measuring a few dimensions with a ruler. Paper may stretch in one direction more than another, so any check should include east–west as well as north–south distances.

6. The deed, referring only to a lot number, is consistent with the survey plat. The original subdivision plat is not entirely

consistent with the survey plat. In most cases, the deed will refer to a subdivision plat, making that plat a part of the deed. The failure of the deed to refer to the subdivision plat, in this case, is not of any consequence. The discrepancies between the subdivision plat and the survey plat of lot 2 should be explained by the Land Surveyor.

7. There are no easements shown. There is no note by the Land Surveyor indicating whether a search for recorded easements was made by his office. This needs clarification.
8. There are no fence lines, buildings, or other structures shown, and there is no note indicating that the property is vacant. This needs to be clarified.
9. The presence of SPCs, distances specified to the one-hundredth of a foot, and bearings specified to the second indicate a high order of precision. This needs to be verified.
10. A review of the title abstract does not indicate any recorded easements, servitudes, rights-of-way, or any other encumbrances to the property. The absence of fences should be explained, as well as the lack of buildings. Perhaps a statement to the effect that these things do not exist is appropriate.
11. The Land Surveyor can now be contacted to respond to the list of questions that have been raised. From this conversation, we learn that the section and quarter corners all have a long history and are well recognized, through perpetuation or recovery of accessories, as the original corners. The work was performed and controlled under the state plane projection system for Nebraska (south zone), North America Datum of 1927. Some of the data was developed over several years of fieldwork in the adjoining sections, although the monumentation of the north and south boundary lines of lot 2 and the Wet River was performed in response to the survey request. All work conformed to the requirements of a "Class A" survey.

Ford has affirmed that the survey plat was developed with the intent that it be used in a transfer of title. Ford also has reported that he believes that the original subdivision plat was an "office" survey that simply divided, on paper, the government version of the dimensions of section 11. His dimensions and directions for lot 2 are his professional opinion of the actual boundaries of lot 2, based on his interpretation of the intent of the subdivider and the constraints of the true configuration of section 11. It is not known if the Wet River shifted east or if the original subdivision plat incorrectly reported the river's location. Ford agreed to add to the plat, in parentheses, old dimensions and directions shown on the subdivision plat to clarify that the existence of the discrepancies is known.

Ford reported that he did not perform a title search for recorded easements or other title restrictions. The property is vacant, wooded lowlands, and subject to inundation. The construction of a reservoir, upstream on the Wet River, is under way and may change the condition of the land.

We have had all our questions about the land answered. A modern survey plat and close communication with the Land Surveyor who developed the plat have made it possible to sell the parcel with a better understanding of just what was being exchanged.

There are some who may balk at accepting a survey of lot 2 that is, apparently, at such variance with the subdivision plat. Those so concerned would do well to reflect on the fact that, if the original subdivision plat version of lot 2 were simply copied, there would be an overlap of 163–247 feet on the east boundary and over 16 feet on both the north and south boundaries. The buyer would be paying for 10.5 acres of land that does not exist or is, at best, under contention. A modern survey of a parcel of land should be ordered if one really wants to know the truth.

Land Surveyors are like doctors or lawyers in this respect: if the surveyor's professional opinion and explanation of that opinion are not satisfactory, then a second opinion should be sought. The very worst thing that one can do is to attempt to persuade the Land Surveyor to distort the survey plat to match the deed. Land cannot be created by words on paper. A Land Surveyor is consulted because of his or her special knowledge of measurements and boundary recovery. Don't reject the Land Surveyor's opinion just because it "rocks the boat," but don't blindly accept that which cannot be explained to your satisfaction either.

12.2. THE LAND GRABBER

Let us assume that you intend to purchase a parcel of land on New York State highway number 10, in Dutch County, near the town of Dutchville, New York. The owner bought the property in 1978, at which time it was surveyed by the owner's cousin (now deceased), who was a Land Surveyor from Albany. The papers presented to you by the owner describe the property as follows:

> . . . That portion or parcel of land bounded on the West by the land of Robert Beckmann, on the North by the lands of Gilbert Hirt, on the East by the lands of John Peters as defined by the old Cromwell Grant line, and on the South by New York State Highway #10 and containing approximately 5 and one half acres commencing and point of beginning at the old stone borne located on the Cromwell Grant line at the North side of New York State Highway Number 10; thence, S 25 E 50′ to the centerline of Highway 10; thence, S 65 W 350′; thence, N 25 W 50′; thence N 25 W 700′; thence, N 65 E 350′; thence, S 25 E 700′ to the point of beginning. . .

This is a poor description, at best, but it is all that the owner has. The local Land Surveyor is Mr. J. D. Times, who is highly recommended by the owner as being "the only man for the job."

In your initial conversation with Times, you advise him that you intend to purchase the property for investment purposes and that you are in the process of obtaining title insurance. Times says that if you send him copies of "all title papers and previous surveys" in your possession, as well as a copy of the results of the title examination by your title insurance company, he will perform the survey.

The title insurance company representative had previously stated that the survey could be done and the plat forwarded to them while the title examination was under way, and you mention this to Times. The sale has a strict time limit, so you urge Times to start immediately. Times agreed to start as soon as a copy of the deed is delivered.

The survey is completed, and several copies of the survey plat are delivered to you. Retaining one copy of the survey plat, you forward the rest to the title insurance company. Figure 12.3 shows the survey plat received by you.

While the title insurance company is completing its work, you decide to evaluate the survey plat, using the checklist that appeared in Chapter 11.

1. The land record system is a metes and bounds system.
2. There is no clear indication of whether a map projection has been used (meaning angles were measured) or whether the plat is simply the result of observed bearings.
3. The survey appears to be the result of recent work. The bearings seem to be imprecise because the minutes and seconds of direction are not shown. This may not be vitally important,

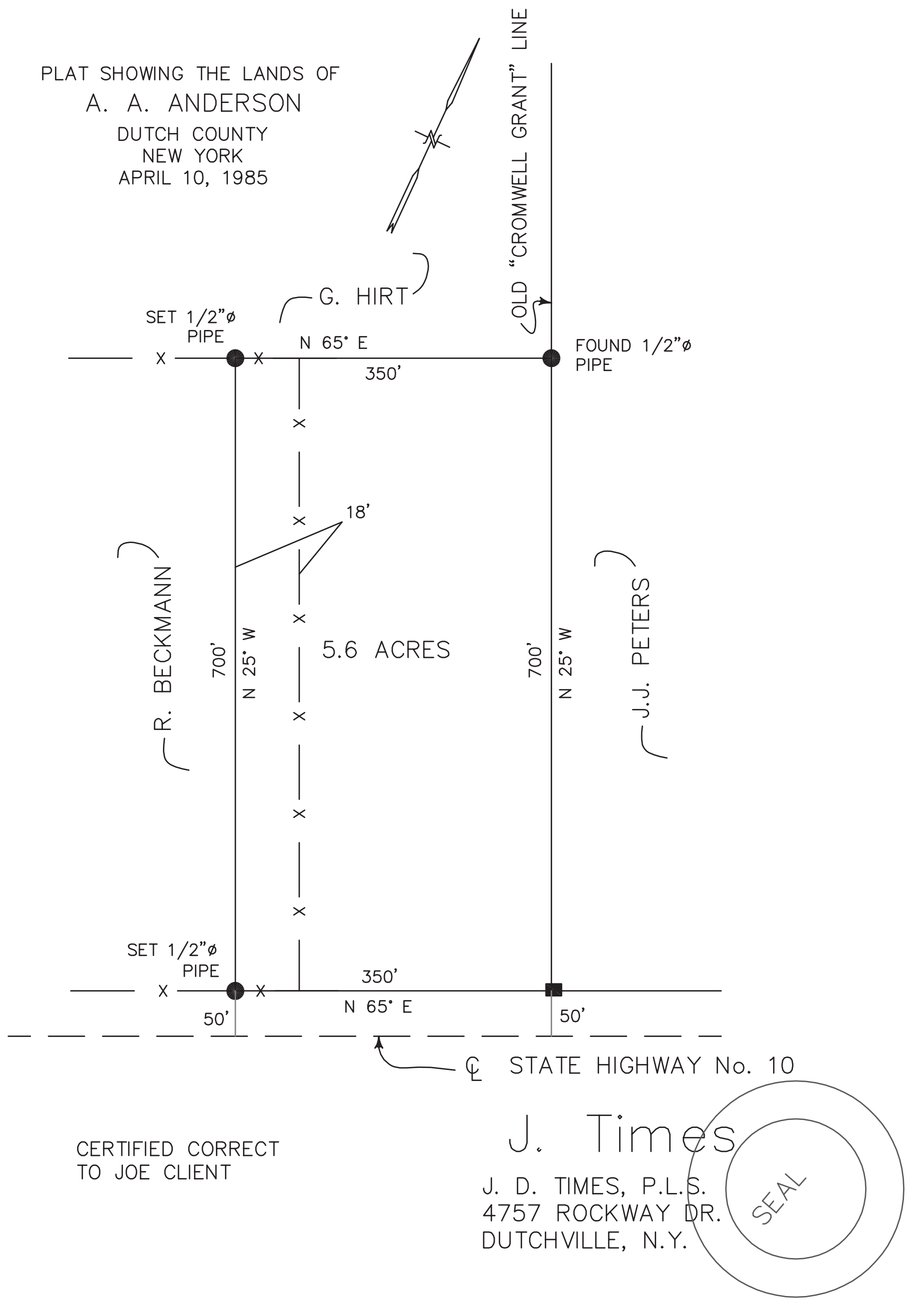

PLAT SHOWING THE LANDS OF
A. A. ANDERSON
DUTCH COUNTY
NEW YORK
APRIL 10, 1985
OLD "CROMWELL GRANT" LINE
G. HIRT
SET 1/2"ø PIPE
N 65° E
350'
FOUND 1/2"ø PIPE
18'
R. BECKMANN
700'
N 25° W
5.6 ACRES
700'
N 25° W
J.J. PETERS
SET 1/2"ø PIPE
350'
N 65° E
50'
50'
℄ STATE HIGHWAY No. 10
CERTIFIED CORRECT
TO JOE CLIENT
J. Times
J. D. TIMES, P.L.S.
4757 ROCKWAY DR.
DUTCHVILLE, N.Y.
SEAL

FIGURE 12.3

considering the small size of the parcel. The distances are all reported to the nearest foot. This may be the result of imprecise work, or it may simply be that Times did not show the tenths and hundredths of a foot if those figures were zero.

4. The purpose of the survey was discussed in depth between you and Times.
5. a. A north arrow is shown, but the bearing base is not defined.
   b. The caption of the plat describes the parcel as "The Lands of A. A. Anderson, Dutch County, New York." This may not qualify as a "legal description," depending on the cadastral records of Dutch County.
   c. The date of the survey is shown, and the work appears to be modern, except for the lack of precision reported in the bearings and distances.
   d. The name and address of the Land Surveyor are shown.
   e. The signature and seal of the Land Surveyor are shown.
   f. All adjoiners are identified.
   g. All dimensions are shown and appear to be consistent.
   h. All bearings are shown. The bearing base or method of determining the bearings should be clarified.
   i. The name of the client is shown.
   j. The plat is "certified correct" to you. This particular wording of the certification is extremely broad and is becoming very unpopular among Land Surveyors. Your understanding of just what was done by Times would be improved by a more precise certification.
   k. There are no limiting words or phrases, in spite of the fact that there is an apparent encroachment of some 18 feet along the western boundary line.
   l. The area is shown as 5.6 acres, but it is not explained whether that includes the encroachment or excludes it.
   m. There is no scale indicated.
6. The directions and distances are exactly the same as the deed description furnished to Times. As in the old "B" westerns when things were "too quiet," this might be a case of things being "too good," but, considering the small size of the parcel, it is quite probable that a match of distances exists within the acceptable range of precision.

7. There are no indications of any easements, nor is there any note about the extent to which easements were searched for. The conversation with Times when the survey was ordered clearly indicated that Times would not perform a title examination.
8. There is an extensive fence encroachment along the entire west boundary line with R. Beckmann. This is a serious encroachment that encumbers $^1/_3$ of an acre.
9. The property is quite valuable and subject to commercial development. It is not possible to tell from the survey plat what the accuracy standards were for this survey.
10. The title records indicate a 10-foot easement "across the entire rear or northerly line" of the parcel. This information should be added to the plat. Clarification is required on the encroachment. Times needs to investigate, if he hasn't already done so, the titles to the Beckmann and the Hirt properties.
11. You contact Times with a list of questions resulting from the examination of the survey plat and receive the following clarifications. The survey was performed by "side shots" from a random traverse around the parcel. The bearings shown are based upon the reported direction of the "Cromwell Grant" line, as monumented by the stone borne and $^1/_2$-inch-diameter iron pipe (therefore, the plat is a tangent plane projection). Times estimates that the distances shown are accurate to plus or minus $^1/_2$ inch and that the direction shown is accurate to plus or minus 20 seconds. (This is consistent with a "Class B" survey.)

Times reported that there are no visible indications of any easements or other encumbrances to the property except the apparent encroachment of a fence line, which is shown. The fence is not very old, according to Times, and it appears that Beckmann has fenced in more than he has "a right to." Times recommends that the boundary with Beckmann be settled before any purchase is made. The title insurance company reports that they will insure title to that portion of the property that is not in conflict (332 feet wide). Times also agreed to add the easement found during the title search to the plat.

The Land Surveyor cannot, and should not, pass judgment on whether or not Beckmann has "a right" to the strip of land between the fence line and the deed line. Beckmann's deed may not reflect a written claim to the 18-foot strip, but there may have been a transfer of rights based on acquisitive prescription.

Land Surveyors do not establish boundaries. Times had performed all the work that he is qualified to perform. He has uncovered and documented evidence of a conflict between the lines of possession and the written deed, thereby providing you with all of the pertinent facts about the parcel that you need in order to make a decision. Times cannot warrant that Beckmann's possession can be ended. The boundary is in doubt, and only an agreement between owners or a court decision can settle it.

You may purchase the property and attempt to settle the question about the boundary. You may require the owner to settle the question about the boundary before any purchase is made. You may decline to purchase the property. These options should be considered in consultation with *your* attorney, not the title insurance company's attorney. Times may appear on your behalf, testify to the facts discovered by him, offer an opinion about the boundary, and many other things, but he cannot establish the boundary contrary to Beckmann's possession or consent. The survey plat can only serve as documentation of the extent of the conflict.

12.3. EASEMENT SURPRISE

Let us assume that you are a real estate investor contemplating the purchase of a large building in an industrial area. The present owner purchased the property in 1965, and a copy of the survey performed at that time is shown in Figure 12.4. The owner states that he has not made any improvements to the property since the purchase.

Referring back to the checklist, you determine the following:

1. The parcel is a part of a platted subdivision.
2. The note that all corners are 90 degrees indicates that the plat is a tangent plane projection.
3. The survey is dated and appears to conform to the standards of practice during the 1960s.
4. The survey was for the purpose of assisting in the documentation of a sale.
5. a. North is shown, but no bearings are shown.
   b. The description shown is based on the subdivision plat and is sufficient to identify the plat.
   c. The date of the plat indicates that it is over 40 years old.

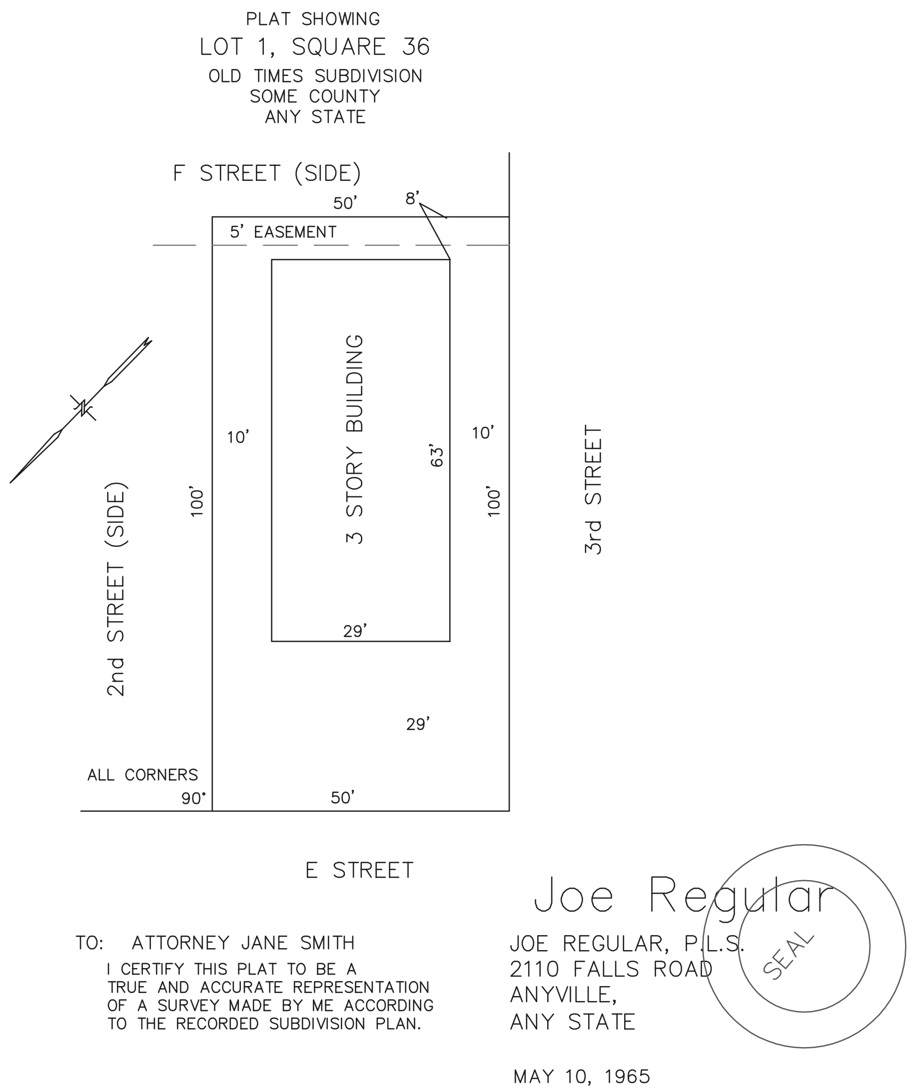


FIGURE 12.4

d. The name and address of the Land Surveyor are shown.
e. The signature and seal of the Land Surveyor are shown.
f. The streets bounding the square are shown. This is a common and excepted means of defining the boundaries of a lot in a platted subdivision in many communities.
g. The dimensions of all sides are shown. The fact that the tenths and hundredths of a foot are not shown may be the

result of an attempt at brevity, as far as the lot boundary lines are concerned. The lack of fractions in building offset lines and dimensions is more likely to be the result of imprecise work.

h. The angles at the corners are reported to be 90 degrees.
i. The name of the client is shown.
j. The certification is present and warrants that the drawing faithfully reflects what J. Regular discovered during his survey.
k. The certification contains the limiting words "According to the Recorded Subdivision Plan."
l. The area is not shown.
m. The scale of the plat is not shown.

6. The deed only refers to the parcel by naming the lot, square, subdivision, county, and state. The lack of a metes and bounds supplementary description removes any possible check for blunders in listing the identification of the lot.
7. The plat shows a five-foot easement across the east side of the parcel.
8. There are no apparent encroachments.
9. The implied precision of the plat requires clarification.
10. The limiting phrase by Regular is notice that the *only* record that Regular relied on for data concerning lot 1 was the recorded subdivision plan and the discoveries, measurements, and observations made by him during the survey.
11. When he was contacted to clarify the questions raised by the checklist, Regular confirmed that he did not perform any search of the deed record for anything other than information on the locations of the exterior boundaries of the lot. The subdivision plat indicated the easement line shown without reference to the party enjoying the rights of that easement. Regular reported all distances and angles to be consistent with the accuracy requirements of a "Class B" survey. The building is constructed of a rough, shingled exterior and is in disrepair. Regular recommended that you obtain title insurance, which you decline to do (it costs too much).

Unknown to all in this scenario was that a 10-foot easement had been acquired by a major gas service company along the entire east boundary of the lot. The easement was acquired only two years after the subdivision was created, one year before the construction of the building. The hidden 2-foot encroachment is a ticking time bomb that will hinder the marketability of this property as soon as it is discovered.

12.4. EXCESSIVE PROBLEMS

John Mason, a local developer and home builder, decided to build a "spec" house on lot 1, block C of East Kingston Heights subdivision, local county, our state. Mason is the owner and developer of both Kingston Heights subdivision and East Kingston Heights subdivision. Work progressed rapidly in both subdivisions. As part of the construction loan to Mason, the lender, Easy Money Inc., required that an ALTA/ACSM land title survey be performed at the end of construction. The work was completed on the house in July of 1986, and Figure 12.5 shows the survey plat requested and used by Easy Money Inc., along with a complete title examination by Nit Pic Title Inc.

An application of the evaluation checklist to this plat reveals the following:

1. The land record system governing this parcel is the platted subdivision system.
2. The mapping system is probably some form of a conformal projection. It may be a tangent plane or state plane projection, but, for a parcel this small, it is not very important to distinguish which one is in use.
3. The survey is fairly modern, both chronologically and procedurally.
4. This survey was done for the purpose of fulfilling the boundary survey requirements of an ALTA/ACSM land title survey.
5. a. The north arrow is shown without a direct reference to a bearing base.
   b. The legal description is shown on the plat as "lot 1, block C, East Kingston Heights subdivision, as recorded in book 324 folio 15, local county, our state." This description is consistent with the land record system in force.
   c. The date of the survey is shown.
   d. The name and address of the Land Surveyor are shown.

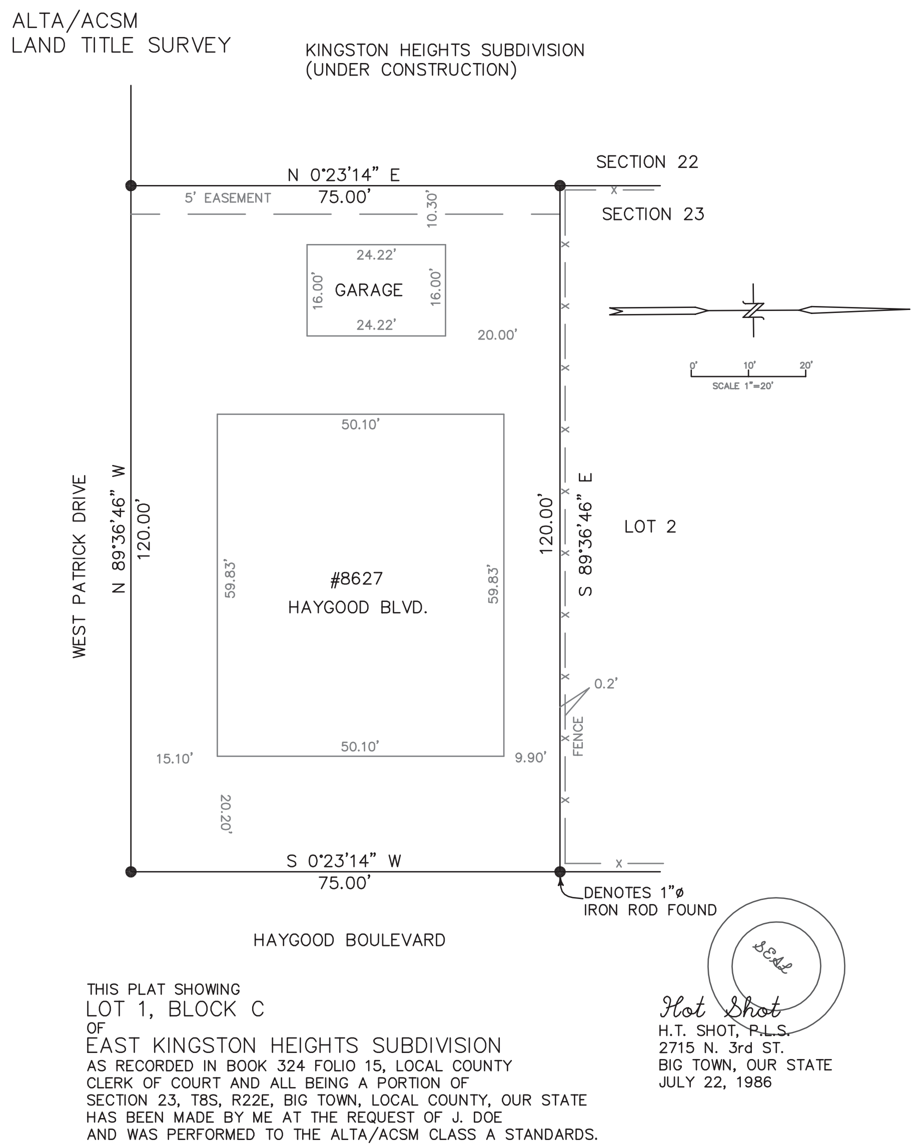


FIGURE 12.5

e. The signature and seal of the Land Surveyor are shown.
f. The adjoining properties are shown as street rights-of-way, lot number, or section number.
g. The dimensions of all sides are shown.
h. The bearings of all sides are shown.

i. The name of the client and the purpose of the survey are stated.
j. The certification is not worded in exact accordance with the requirements of an ALTA/ACSM land title survey.
k. The reworded certification contains the implication of limiting the records search by H. T. Shot to the recorded subdivision plat.
l. The area is not shown.
m. The scale is noted to be "1" = 20'" and is accompanied by a bar scale.

6. The subdivision is new, and a prior deed for this particular lot did not exist. The survey plat of lot 1 block C is consistent with the subdivision plat.
7. There is an easement across the entire western end of the lot. The title examination did not reveal any other easements or other noteworthy items of record.
8. There are no encroachments. The fence along the northern boundary of the lot is not considered by Nit Pic Title Inc. to be an encumbrance.
9. The survey standard of "Class A," as defined by the "Minimum Standard Detail Requirements for ALTA/ACSM Land Title Surveys," is of the highest order of accuracy for boundary surveys.
10. The certification should be changed to meet the ALTA/ACSM standard certification.
11. This step was not taken by Easy Money Inc.

Mrs. Gracie A. McCoy purchased this house in August 1986. The mortgage company that financed this purchase, Cut Rate Loans Inc., used the July 22, 1986, survey by H. T. Shot, P.L.S. to document this sale. Nit Pic Title Inc. has the local reputation of being extremely meticulous, Easy Money Inc. is known to be a very cautious lender, and H. T. Shot's reputation is excellent. Cut Rate Loans did not require a new title examination, nor was an updated survey requested.

Eventually, Kingston Heights subdivision was also completed. The house and lot directly west of 8627 Haygood Blvd. was purchased by A. M. Schorr in January of 1987. On February 2, 1987, McCoy and Schorr agreed mutually to fund a fence along the line dividing their properties. The survey marks on Schorr's eastern boundary were visible, so the fencing company used these marks to build a wood fence along Schorr's eastern line.

McCoy became dissatisfied with the size of her garage, razed it, and rebuilt the garage to the dimensions of approximately 24 feet × 24 feet. Mrs. McCoy became dissatisfied with the entire house and sold it to R. R. Robert. This sale was also financed by Cut Rate Loans. The appraiser for Cut Rate Loans inspected the property in May of 1987 and noticed that the new garage was over seven feet east of the west fence line. No other construction had taken place. No survey was required by the buyer or the lender for this new sale.

In August 1988, R. R. Robert agreed to sell this same house (at a great profit) to Schorr's widowed mother-in-law, B. Axer. The loan for this sale was handled by Easy Money Inc., which immediately ordered a resurvey of this lot, in spite of the existence of a recent ALTA/ACSM land title survey on this property, dated July 22, 1986. This survey is shown in Figure 12.6

The reader may evaluate this survey plat, as well as contemplate the many solutions to the problem presented. The savings realized by not requiring a boundary survey for each exchange of title cannot compare with the losses that will result from the complicated lawsuit that Robert is about to bring against all involved. The rule of thumb in real property transfers is, "The land survey is too expensive when it is more than the cost of possible losses or the value of the land."

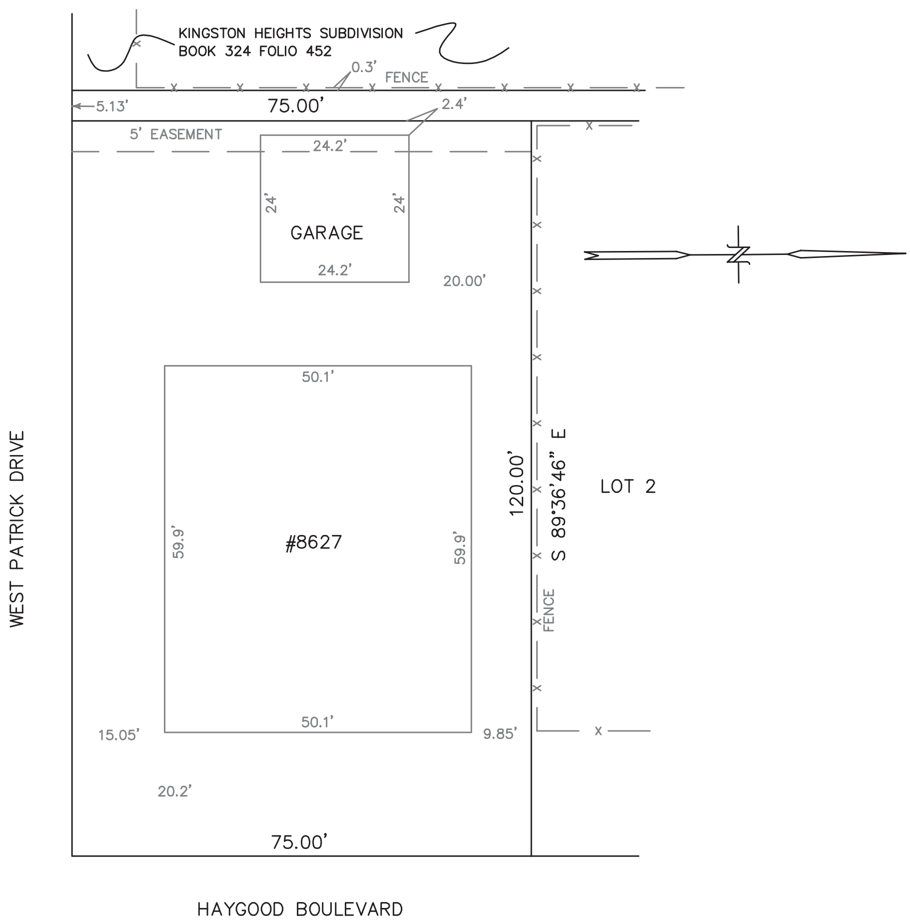
12.5. METES MEETS BOUNDS

Abraham Savings and Loan (AS&L), located in Capital City, east state is in the process of providing a mortgage loan to Mr. William Cheatham. Mr. Cheatham provided a copy of a survey plat, showing the property to be mortgaged. Figure 12.7 shows that survey plat.

You are a loan officer with AS&L and have been assigned this loan. Using the checklist from Chapter 9, you discover the following:

1. The land record system is a metes and bounds system. Two separate parcel histories (Johnston estate and Mills tract) must be examined for title certification in order to insure prime lien on the property. A copy of the survey plat is sent to the title insurance company, along with a request for insurance.
2. This is clearly a tangent plane projection survey.

LOT 1
BLOCK C
EAST KINGSTON HEIGHTS
SEC. 23, T8S R22E
LOCAL COUNTY, OUR STATE



I CERTIFY THIS PLAT TO BE A TRUE AND ACCURATE REPRESENTATION OF A SURVEY MADE BY ME AT THE REQUEST OF WILLIAM BEES, ATTY.

AUG. 15, 1988

NOTE: THIS SURVEY IS BASED UPON THE RECORDED SUBDIVISION PLAT AND INFORMATION PROVIDED BY THE CLIENT. NO SEARCH OF THE TITLE RECORD WAS MADE BY THIS OFFICE.

SEAL

Ben Dere
BENJAMIN DERE, P.L.S. #101
2719 N. 3rd STREET
BIG TOWN, OUR STATE

FIGURE 12.6

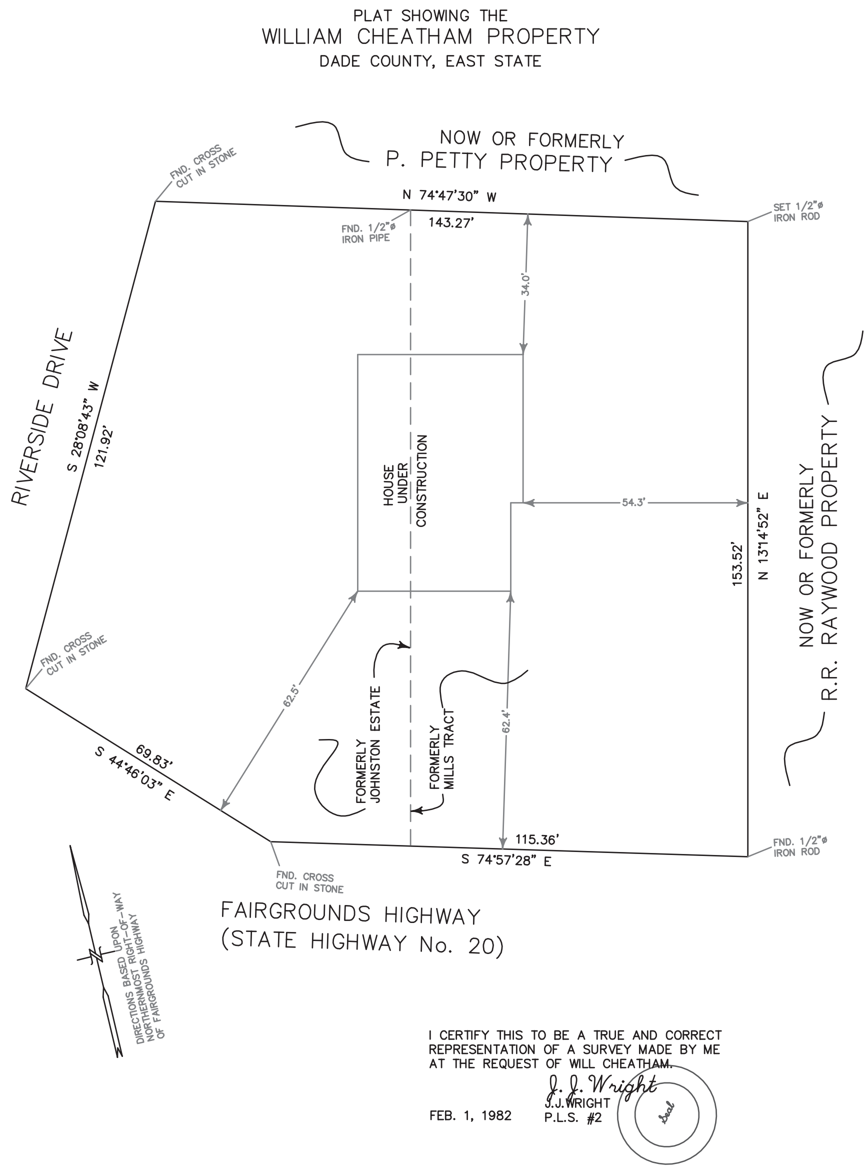


FIGURE 12.7

3. The precision of the work seems to be modern.
4. The purpose of the survey appears to be documentation that the house under construction is within the property lines. The fact that a house is shown as "under construction" may be of serious concern if this is to be a first mortgage.

5. a. The north arrow is shown, and the bearing base is defined as the "call" direction for the Fairgrounds Highway (assumed north).
   b. The legal description is "the William Cheatham Property, Dade County, east state," along with the bounds shown.
   c. The date is shown.
   d. The name of the Land Surveyor is shown, but no address is given.
   e. The signature and seal of the Land Surveyor are shown.
   f. All adjoiners are shown.
   g. All dimensions are shown.
   h. All directions are shown.
   i. The name of the client is shown.
   j. The certification is very general and gives no hint about the intended purpose of the survey.
   k. There are no limiting words or phrases.
   l. The area is not shown.
   m. The scale is not shown.
6. The deed presented to you by Cheatham describes the property as being bounded by Riverside Drive, Fairgrounds Highway, the property of B. B. Mills, and the property of P. Petty, and more particularly described as:

   > . . . Commencing at the corner of Fairgrounds Highway and Riverside Drive and True Point-of-Beginning; thence, South 75 degrees East along Fairgrounds Highway, a distance of 32 feet no inches; thence, North 13 degrees 15 minutes East, a distance of 153 feet no inches; thence, North 75 degrees West for 65 feet no inches; thence, fronting on Riverside Drive 122 feet no inches and a second fronting of 70 feet no inches to the point-of-beginning. . .

   The deed, though poorly written, clearly describes only a portion of the property depicted on the survey plat. No reference is made to the inclusion of the Mills tract.
7. No easements are shown.
8. No encroachments are shown onto or from the Cheatham property.
9. Accuracy standards are not stated.

10. Discrepancies between deed and the survey plat are profound and must be explained.
11. A telephone call to the Land Surveyor (the east state board of registration provided an address and a telephone number) reveals that the survey plat was prepared to assist in the resubdivision of the Mills tract and the Johnston estate into one parcel. The local county ordinances require the introduction of a plat of resubdivision, along with proof of ownership by the parties requesting the resubdivision. The county, upon approval, records a signed copy of the survey plat as the official plat of resubdivision.

The title insurance company reported that Cheatham's title to the Johnston estate was free and clear. The Mills tract was purchased by Cheatham Enterprises, Inc. and carries a mortgage in favor of First Bucks International for $125,000. There is no record of a resubdivision combining the two parcels.

12.6. THE SQUARE THAT WASN'T THERE

In 1997 you were requested by Cut Rate Loans Inc., a mortgage company, to examine the title on a parcel of land identified as "lots 1 through 22, square 16 Grandsire Farms, section 8, T4N R21W, this county, some state." The purpose of the title examination was for an act of sale, 70 percent financed by Cut Rate Loans, from the estate of O. Fogey to B. C. Jingwaski. Fogey acquired the property in 1908 from Night Investments, Inc., which had purchased all of section 8, T4N R21W from the U.S. government in 1899. Figure 12.8 shows the subdivision plat of Grandsire Farms that was attached to the 1908 conveyance.

The subdivision of Grandsire Farms had only been partially developed at the time. Some streets had been improved, some squares had been resubdivided, and some areas were untouched woodlands. Jingwaski acknowledged that he was aware that square 16 and the surrounding street rights-of-way were heavily wooded and undeveloped. This area had become a rapidly developing suburban area of Cin City, and the sale price for square 16 was $800,000.

The examination of the conveyance record revealed only two exchanges involving square 16: The first was the sale by the U.S. government to Night Investments of all of Section 8, and the second was

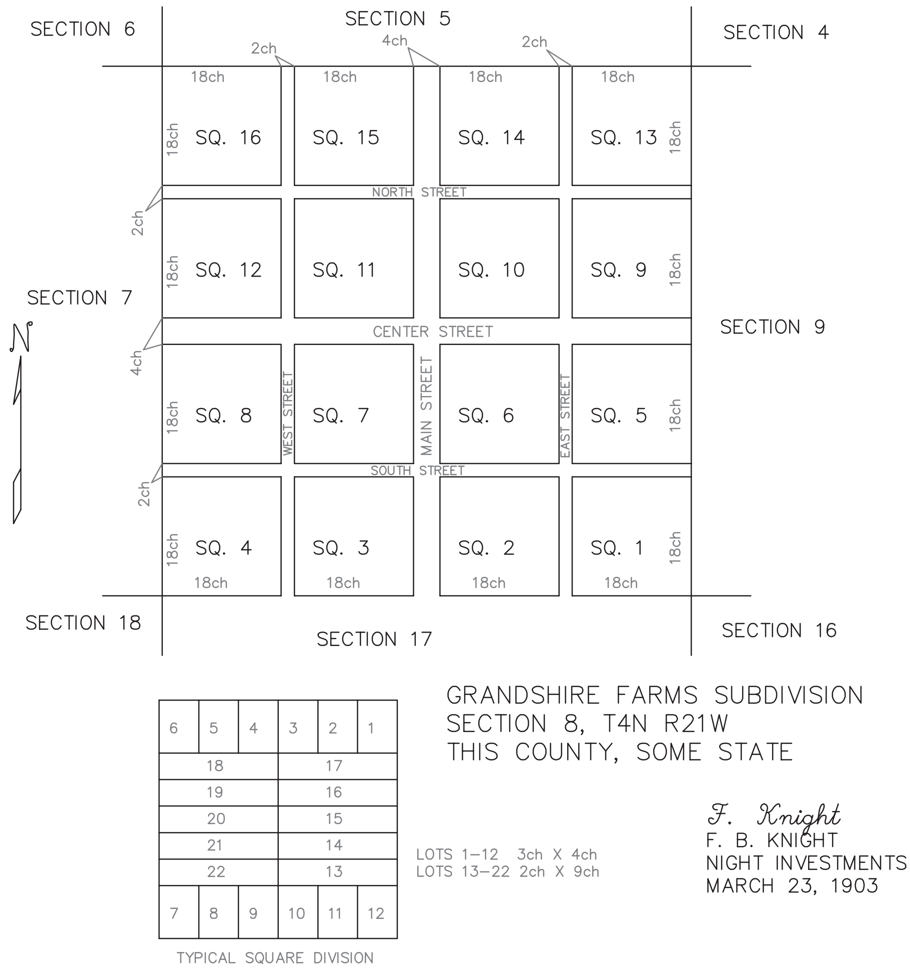


FIGURE 12.8

the sale by Night Investments to Fogey of lots 1 through 22, Square 16 "being all of Square 16." The record was as clean as you had ever seen.

An evaluation of the subdivision plat, using the checklist from Chapter 9, provides the following:

1. The land record system is a recorded subdivision plat.
2. The presence of cardinal directions (north, south, east, and west) and the lack of any indication that angles were measured indicate that this is a projectionless map.

3. The plat is dated March 23, 1903, but, because all of the distances are to the nearest chain and all of the directions are cardinal, you suspect that the last work done on this parcel was by a U.S. government surveyor prior to 1899.
4. The purpose of the plat (there was great doubt that a survey was ever conducted) is to create Grandsire Farms subdivision.
5. a. The north arrow is without reference to a bearing base.
   b. The legal description is indicated by the numbers in designated lots and squares. The legal description of Grandsire Farms is on the face of the plat.
   c. The plat is dated 1903.
   d. The name and address of the "surveyor" are shown.
   e. There is a signature but no seal.
   f. Adjoining properties are shown.
   g. All dimensions are shown. The exterior dimensions are identical to a regular USPLS section.
   h. Bearings are shown on the section boundaries only.
   i. The name of the client is shown, and the purpose of the plat is obvious.
   j. There is no certification.
   k. There are no limiting words or phrases.
   l. No areas are shown.
   m. There is no scale shown on the plat.
6. The deed only refers to lot and square numbers. There is no supplemental description.
7. Street rights-of-way are the only features shown on the plat.
8. No improvements are shown. You are familiar with the area and know that it is free of any fences, buildings, or cultivation.
9. You feel that $800,000 worth of land in a rapidly developing area adjacent to Cin City calls for a "Class A" survey.
10. The 1903 subdivision plat does not fulfill very many of the requirements of an ALTA/ACSM land title survey.
11. The "surveyor" has been dead for 32 years.

You advised Cut Rate Loans that you would require that a new survey be performed on the property being sold. Your surveyor quoted a cost of $8,450.00 to perform an ALTA/ACSM land title survey. Cut Rate

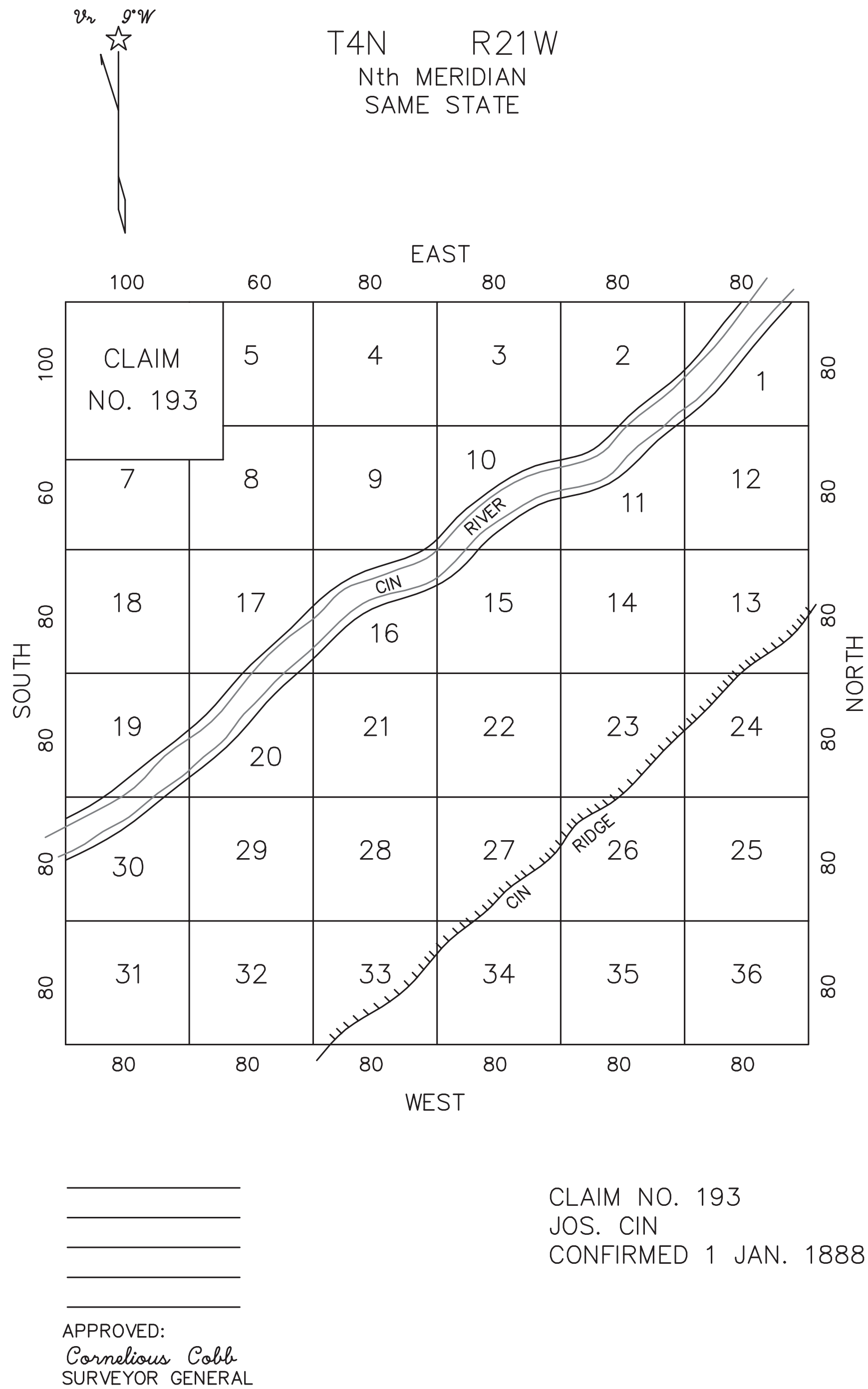
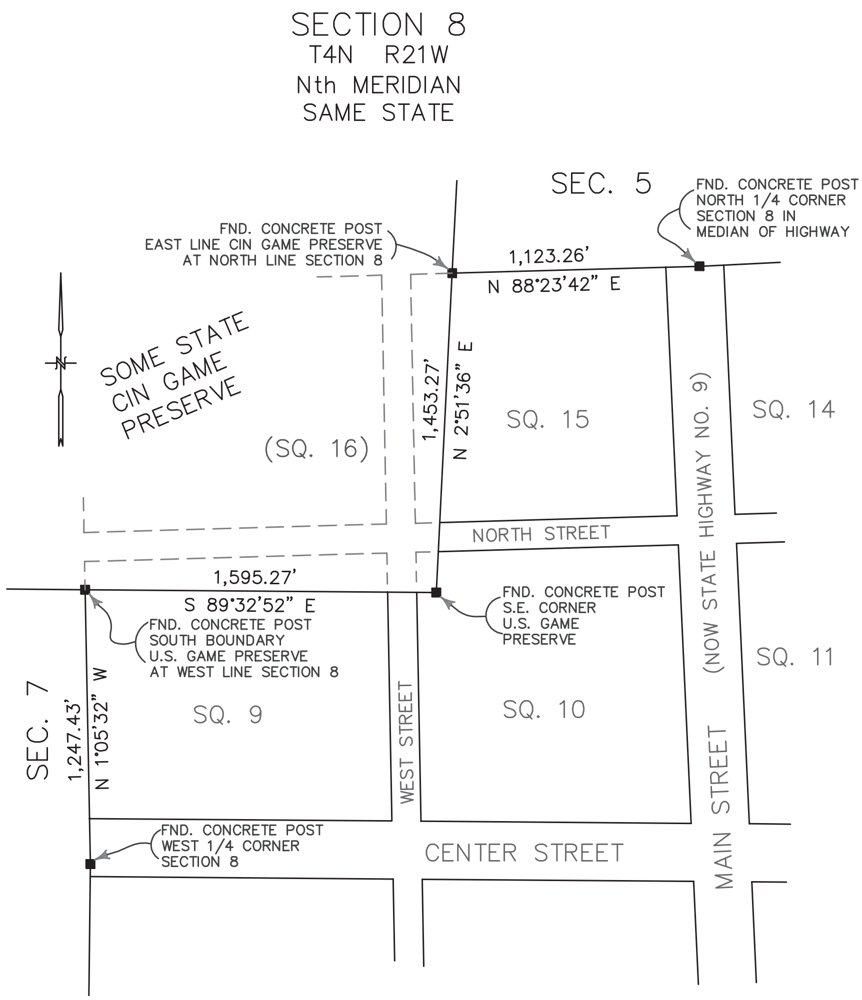

Vr 9°W
T4N R21W
Nth MERIDIAN
SAME STATE
EAST
100
60
80
80
80
80
CLAIM
NO. 193
5
4
3
2
1
7
8
9
10
11
12
18
17
16
15
14
13
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
CIN
RIVER
CIN
RIDGE
SOUTH
NORTH
WEST
80
80
80
80
80
80
CLAIM NO. 193
JOS. CIN
CONFIRMED 1 JAN. 1888
APPROVED:
Cornelious Cobb
SURVEYOR GENERAL

FIGURE 12.9



I CERTIFY THAT THIS PLAT IS A TRUE AND ACCURATE REPRESENTATION OF MY ATTEMPT TO SURVEY SQUARE 16, GRAND SHIRE FARMS AS SHOWN ON THE SUBDIVISION PLAT BY F.B. KNIGHT cir 1903

JUNE 7, 1990
C. Brushcut
C.W. BRUSHCUT, P.L.S.
SOME STATE

FIGURE 12.10

Loans and Jing-waski both knew that the land was heavily wooded and completely vacant. Both decided that there was no possibility of any adverse possession and declined to commission a survey. (Who ever heard of paying $8,500 for some guy to stick pipes in the ground in the middle of nowhere?)

Last week, Bigbucks Development, Inc. signed a purchase agreement with Jingwaski for all of square 16 Grandsire Farms for the sum of $1,250,000. Bigbucks Development contracted with a surveying and engineering firm to survey square 16 and to design a single-family home-site development. Bigbucks Development directed the Land Surveyor to send the survey of square 16 to you to be used in the title examination for their purchase from Jingwaski. Today, the Land Surveyor, C. W. Brushcut, presented you with Figures 12.9 and 12.10. Figure 12.9 shows the U.S. township plat for township 4 north, range 21 west. Figure 12.10 shows his survey plat of square 16.

"Call me when you have a chance," said Brushcut as he left.

A GUIDE TO UNDERSTANDING LAND SURVEYS
STEPHEN V. ESTOPINAL

CHAPTER 13

WRITING LEGAL DESCRIPTIONS

The definitions of "legal description" and "land description" are sometimes thought to be interchangeable. However, there is a subtle difference between the two, and neither definition is exactly what the modern use of the phrase "legal description" has come to mean.

A legal description is "a description recognized by law which definitely locates property by reference to government surveys, coordinates systems or recorded maps; a description which is sufficient to locate the property without oral testimony." A land description is one that defines "the location of a parcel of land described in a narrative format." A metes and bound description is "a description of a parcel of land by references to course and distances around the tract, or by reference to natural or record monuments."[1]

The use of the phrase "legal description" has evolved to mean the body of words and phrases used within a real property deed to depict a specific parcel of land in a way that identifies that parcel, not only in terms of the land record system used to create the parcel, but also in terms of delineating the size, shape, and location of the parcel so specifically that recovery of the boundaries of that parcel is possible using only the written description.

In other words, the modern lexicon has combined "legal description" with a "metes and bounds description" to mean the combination of

[1]American Congress on Surveying and Mapping and the American Society of Civil Engineers, *Definitions of Surveying and Related Terms,* 2005 (rev.).

phrases that are to be included in the deed. This particular “legal” or “land” description takes the same form in every land record system and, because we will only concern ourselves with descriptions within deeds, will be called the “deed description” hereafter.

This chapter will be devoted to developing the art of writing deed descriptions that are clear, complete, concise, and consistent (with the land record system in use and the intentions of the parties creating the title).

When called upon to determine intent, courts will consider all of the evidence presented in the deed description, as well as other evidence.[2] A well-written deed description will reflect the intent of the parties and will assist some future court in its deliberations. It is imperative that a deed description fully and unambiguously convey the *intent of the parties*.

There will be only one recommended form of deed description covered in this chapter, and no attempt will be made to discuss the portions of the deed that cover the specific rights conveyed, conditions of the sale, and so forth. Many other forms of deed descriptions in use across the United States are very regionally oriented and are being gradually replaced by this more universal and flexible form. The method proposed here will enable persons with little or no trigonometric or geometric background to write excellent deed descriptions.

The first step in writing a deed description is to evaluate the intentions of the parties to the transaction. In most cases, this intent is to transfer certain rights to an existing parcel. In other cases, a new parcel is being created. Each of these situations has its own particularities that may alter slightly the composition of the deed description.

13.1. CREATING NEW PARCELS

Divisions of a real property into two or more new parcels, combining existing parcels into one, or rearranging the boundaries of existing parcels are all acts of resubdivision. A resubdivision is most easily accomplished by a complete land survey and the development of a subdivision plat by a Land Surveyor. Although other land record systems allow for resubdivision of land, the platted subdivision accomplishes this so clearly and effectively that most local city and county

[2] J. S. Grimes, *Clark on Surveying and Boundaries*, 4th ed. Bobbs-Merrill Co., Inc.: Indianapolis & New York, 1976.

governments now require platted subdivisions for all divisions of real property within their jurisdictions.

A new survey should be performed to collect the information about the property needed in order to decide upon division. Old survey plats will not reflect accurately present conditions or discover changes in boundaries. Current information is vitally important. Without it, the parties to the transaction may be misled.

Divisions of real property based on ancient data risk severe conflicts when, at a later date, the resulting parcels are possessed and it is discovered that the parent tract was not the size and shape it was believed to be. The creation of a platted subdivision affords the owners an opportunity to discover and to correct any dimensional discrepancy that may have existed in the old deed information. Once in possession of complete and accurate information on the actual present configuration of the parent tract, the parties involved in the resubdivision can develop their informed intent and take action without excessive risk of conflict among the assigns.

13.2. EXISTING PARCELS

Most often, a real property transaction involves an existing parcel that is already described in a deed. The current deed may or may not accurately describe the property. Changes in boundary lines may have occurred, or updated information about the boundaries may render portions of the old deed information obsolete. If a deed is to report accurately all of the rights transferred, then it is important that these rights be known. The ALTA/ACSM land title survey procedure[3] is designed to discover all of these rights and to detect possible changes.

13.3. GENERAL OUTLINE

All deed descriptions take the form of a five-part essay consisting of (1) caption, (2) narrative, (3) deletions or additions, (4) summation, and (5) references. Part (2) may be absent if information, beyond the caption, is not known. Parts (3) and (5) may be absent, and the order of (3), (4), and (5) is sometimes rearranged. Nevertheless, deed descriptions that fulfill all of the five parts have proven to be the least likely to be misinterpreted at a later date.

[3]See section 11.23.

13.4. THE CAPTION

The caption usually takes the form of identification that is most basic to the land record system appropriate to the parcel and is almost always the legal description of the parcel. In United States Public Land Survey (USPLS) and platted subdivisions, the caption is always distinct from the rest of the description.

In the metes and bounds system, the caption and the narrative may merge if caution is not exercised. To avoid this possibility, the phrase "and more particularly described as follows" or words to that effect are sometimes added at the end of the caption to alert the reader that the narrative section of the deed description is about to begin. The caption should also be segregated from the body of the deed description as a separate paragraph. Here are some examples of possible captions:

> That parcel of land designated as Lot 1, Square 12, Timber Estates, Waterproof, Louisiana, more particularly described as follows: . . . (platted subdivision)
>
> That parcel of land known as the "Brown Estates" located in Winston County, Kentucky bounded on the north by J. R. Westly, on the east by Philip Jones, on the south by D. Davis and on the west by Kentucky State Highway Number 5, more particularly described as follows: . . . (metes and bounds)
>
> That parcel of land designated as the NE$^1/_4$ of Section 2, T5S R4E, Fourth Principal Meridian, Hayseed County, Illinois, described as: . . . (USPLS)

The common factor in each of these examples is that the *caption alone is sufficient to identify the parcel without oral testimony*, based on the prevailing land record system. The land record system in the examples is noted within parentheses following the caption.

The identification in the caption is not normally negated by a contradiction occurring in the narrative portion of the deed description, unless it can be shown that the caption contains an error. If, for example, in a platted subdivision, the caption identifies a parcel by lot, square, and subdivision, according to a recorded subdivision plat, and the narrative portion reports a contradictory distance to a street corner, the caption (and the recorded plat that is an integral part of the caption by reference) will usually be assumed to be correct, unless additional evidence to the contrary has been found.

13.5. THE NARRATIVE

The narrative portion of the deed description always takes the form of a complete metes and bounds description, beginning with a commencement point, through a point-of-beginning, around the parcel, and returning to the point-of-beginning. The narrative forms separate paragraphs that consist of a single sentence.

The distinctions of calls for specific boundaries, bearings, distances, landmarks (monuments), and other factors discussed in Chapter 7 dealing with metes and bounds land record systems apply in a deed description. The narrative portion of a deed description is the same for all land record systems and is dependent on a survey's having been performed on the parcel being described.

Divisions of property that take place without a survey, such as the aliquot division of a section, should not have a narrative portion in the deed description.

As many of the key factors of a metes and bounds description as may exist must be presented in the narrative portion of a deed description, and, on the off chance that the reader did not read that section or does not remember it, the key factors will be repeated here.

The metes and bounds narrative must contain the following:

1. A commencing point that is well known, easily found, durable, recoverable, recognizable, and preferably public in origin.
2. A point-of-beginning that is a distinct part of the parcel being described.
3. A report of the physical objects (monuments) that mark the location of the ends or are found along each line.
4. A report of the owners or parcel identifiers of the contiguous properties along each line.
5. A direction for each line. This can be in the form of a bearing, an angle, or, in the case of curved lines or meandering lines, a description of the configuration of the line.
6. A length of each line segment, usually in the form of a distance between corners.

There are several recommended key words or phrases that should be used in the narrative of a deed description that are intended to assist the reader in identifying which of the preceding items is about to be reported or to clarify some other aspect of the description. Custom in a particular area may mean that a different combination of key words or phrases will be used to express the intent of the parties. In these areas, the introduction of the recommended system should be made gradually or with slight modifications for the sake of continuity.

How corner monumentation is identified is also significant in illustrating the intentions of the parties. Each region has developed certain preferred objects used to monument corners. Terrain, agriculture, local industries, geology, and other factors unique to a region all influence the materials used in the monumentation of real property corners.

The format recommended here is easily adapted to a wide variety of regional customs and practices involving identification, monumentation, and description of real property. Once this format becomes a habit, reading or writing the narrative portion of a deed description will become the simplest part of working with real property identification and boundaries.

13.6. KEY PHRASES

13.6.1. "Commencing At"

"Commencing at" normally are the first two words of the narrative portion of a deed description. The reader is alerted to the fact that items following this phrase will be a physical object and/or a distinct theoretical land point that, in the opinion of the writer, fulfills most, if not all, of the requirements enumerated for commencement points.

The commencement point must be just that—a land point. It would not be proper to state, for instance, "Commencing at the northernmost right-of-way line for U.S. Highway 66." The reader is not told where along the northernmost right-of-way line the land point is located. It would be correct to state, "Commencing at the intersection of the northernmost right-of-way line of U.S. Highway 66 and the easternmost right-of-way line of U.S. Highway 15."

The second version clearly designates a land point that any reader of the deed could easily find. Physical objects that monument the commencement point should also be "called for" in the narrative, as well as any state plane coordinates (SPCs) or other pertinent data.

13.6.2. "Point-of-Beginning"

The point-of-beginning brackets the narrative that traces or "traverses" along the boundaries of the parcel being described. This statement prepares the reader to begin sketching a mental picture of the parcel. The point-of-beginning is fundamental to the narrative portion of a deed description and, as with the commencement point, must be a true land point. Physical monuments, as well as theoretical land points, can serve as points-of-beginning. It is quite common for the monument, theoretical location, and SPCs of a point-of-beginning to be included in the narrative.

Although it is sometimes combined with the commencement point, the point-of-beginning cannot be dispensed with. "Commencing and point-of-beginning at . . ." is used when both are the same point, as in a comer lot. The second appearance of the words "point-of-beginning" in a narrative announces the termination of the traverse encompassing the parcel. When it is mentioned the second time, there is no further elaboration of any distinctive features of the point-of-beginning.

13.6.3. "Thence" and ";"

The narrative in a deed description is similar to a Faulkner sentence. From "commencing at" to references, the entire essay comprises one sentence. The word *thence* is used to announce that a new line segment is about to begin. The boundary line segment description always ends with a semicolon (";") giving the phrase that describes a single boundary line segment the appearance "thence, xxxxxxx;."

In this way, the very long narrative can be divided into "digestible" pieces that stand out to the reader. It is important to exclusively reserve these two items (thence and the semicolon) for this particular use. Applications of semicolons or the word *thence* for another purpose anywhere else in the narrative portion of a deed description will certainly cause confusion.

13.6.4. "In a —ly Direction"

The eight general directions of "norther*ly,*" "northeaster*ly,*" "easter*ly,*" "southeaster*ly,*" "souther*ly,*" "southwester*ly,*" "wester*ly,*" and "northwester*ly,*" are especially useful to persons who are not particularly familiar with reading and interpreting bearings. Directions with the suffix *-ly* eliminate confusion over which form of a bearing is applicable for describing a particular line. Examine Figure 13.1.

If the traverse being described includes the line segment from point "A" to point "B," an examination of the north arrow clearly indicates that this requires a move to the south. The phrase "in a *southerly* direction" prepares the reader to expect the bearing "*south* 5 degrees

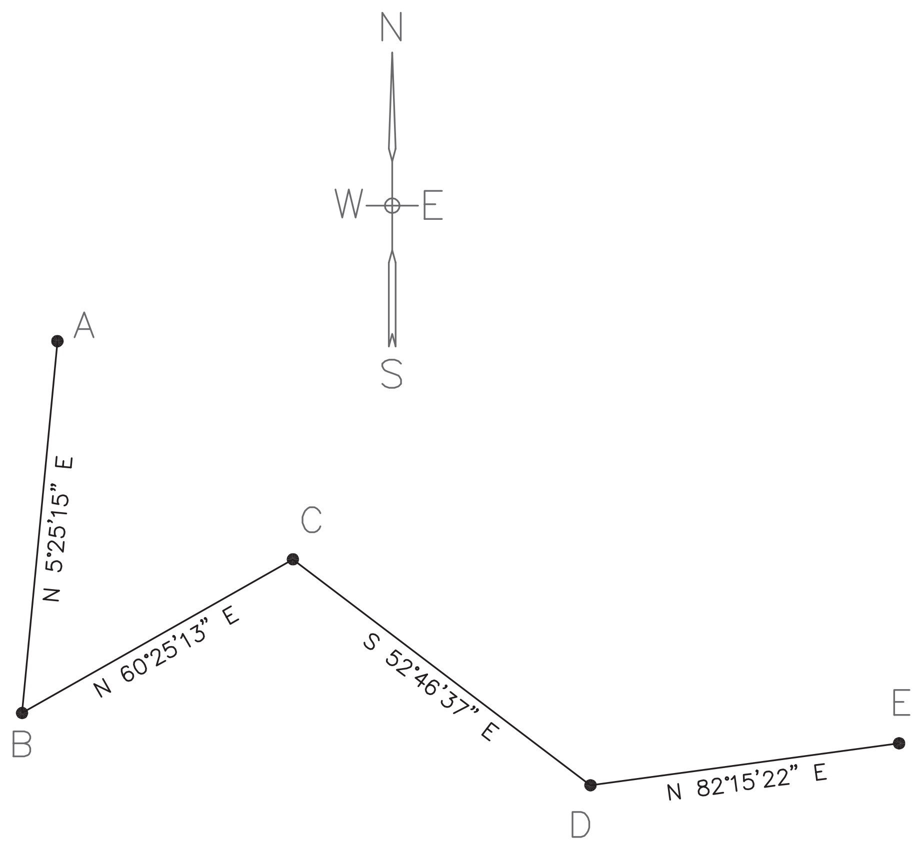


FIGURE 13.1

25 minutes 15 seconds west" instead of "*north* 5 degrees 25 minutes 15 seconds east," which is printed in Figure 13.1.

Similarly, from point "B" to point "C" would call for the use of the phrase "in a *northeasterly* direction" to indicate that the bearing to use is "*north* 60 degrees 215 minutes 13 seconds east." The line segment from point "C" to point "B" would call for the phrase "in a *southwesterly* direction" to indicate that the bearing to use for that direction is "*south* 60 degrees 25 minutes 13 seconds *west*."

Notice that, if in describing the line from point "C" to point "B" the writer had decided to use "in a *southerly* direction" instead of "in a *southwesterly* direction," the choice of bearings would still be "*south* 60 degrees 25 minutes 13 seconds west." The selection of "in a *westerly* direction" also results in "south 60 degrees 25 minutes 13 seconds *west*."

The use of these general directions allows a great deal of freedom of choice. The only limitation in choosing a *-ly* direction occurs when the lines are close to the cardinal directions. Lines that are nearly north–south should use "northerly" or "southerly"; lines that are nearly east–west should use "easterly" or "westerly."

13.6.5. "-Most"

The suffix *-most* is used with the same eight general directions as the suffix *-ly*. The purpose of the general directions is to distinguish between similar or paired items in a way that is obvious by an inspection of the property or its survey plat.

As with the *-ly* directions, there is wide leeway given in the choice of directions using the suffix *-most*. The majority of occasions that require these words can be satisfied with the cardinal directions.

In Figure 13.2, "northernmost," "northeasternmost," "easternmost," and "southeasternmost" all indicate the Jones and Smith side of U.S. Highway 77. Of the four choices, "northeasternmost" and "easternmost" are the most obvious, and equally preferred, selections in this example.

13.6.6. "Along"

The key word *along* indicates that the boundary line being described is congruent with some other previously established line. Whether the previously established line is straight, curved, or meandering, the key word *along* indicates that the boundary line being described is exactly superimposed on the previous line at every point.

For example, ". . . ; thence, in a southerly direction, *along the line between section 5 and section 6* . . . ;" declares the described boundary to be the section line, and ". . . ; thence, in a northerly direction, *along the Snake River* . . .;" leaves no doubt that this is a riparian boundary.

13.6.7. "A Distance Of"

The phrase "a distance of" is sometimes considered to be unnecessary. However, deed descriptions that refer to distances that are not lengths of boundary line segments can become very confusing if this key phrase is eliminated.

For example, examine the excerpt ". . . ; thence, in a southerly direction, along a curved line, having the radius center to the east and a radius of 200.00 feet, 350.00 feet . . ." or ". . . ; thence, in a southerly

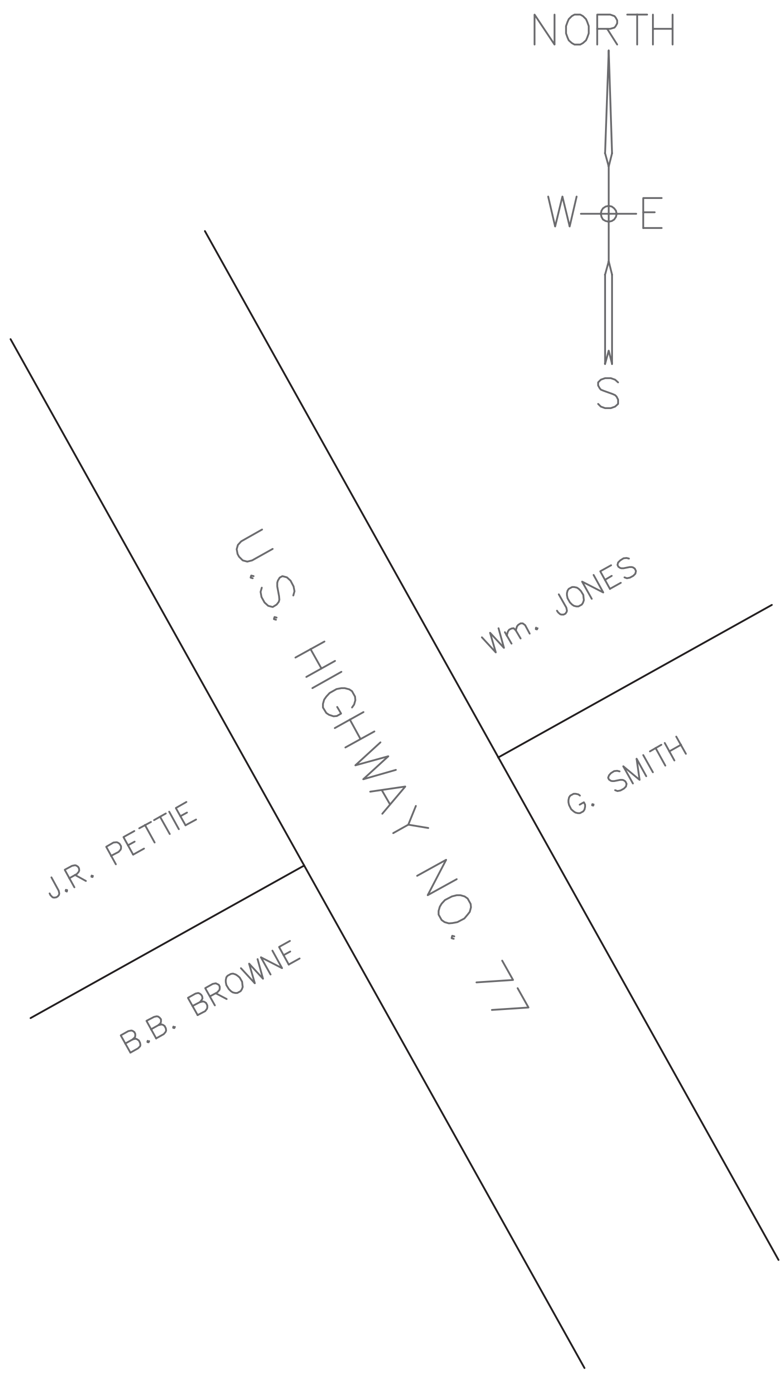

NORTH
W
E
S
U.S. HIGHWAY NO. 77
Wm. JONES
G. SMITH
J.R. PETTIE
B.B. BROWNE

FIGURE 13.2

direction, along a curved line having a radius of 200.00 feet and the radius center to the east, 350.00 feet . . ." is not as clear as ". . . ; thence, in a southerly direction, along a curved line, having the radius center to the east and a radius of 200.00 feet, *a distance of* 350.00 feet . . ."

13.6.8. "To" and "To a Point"

The key word *to* is of special significance in demonstrating the intention of the parties in a transfer of titles. *To* announces that the boundary line segment is being terminated and that the corner description that *immediately* follows the word *to* is considered by the writer to control the length of the boundary line segment. The words "to a point" indicate that the limit is not set by a physical feature but by a theoretical location. Many other supplementary descriptions of the corner, or accessories to the corner, may follow the primary one. This distinction is best explained by example:

". . . 723.32 feet *to the easternmost boundary of the Jones estate*, that same point being monumented by a 1-inch diameter iron pipe; . . ." clearly designates the "Jones estate" (an adjoining property) as the limit of that line segment. By using this phrase, the writer is stating that, if, for some reason, the one-inch diameter iron pipe was found to be short of the Jones estate or the distance called for was insufficient to reach the Jones estate, the limit of the line segment would not be the pipe or the distance but would continue on to (or stop at) the easternmost boundary line of the Jones estate.

". . . 723.32 feet *to a point* monumented by a 1-inch diameter iron pipe; . . ." indicates that the intention of the parties was to set the length of the line at *a specific distance* (723.23 feet), and, if the pipe were later to be found to be short of, or in excess of, that distance, the distance would prevail (in the absence of possession or other convincing and contradictory evidence). In this instance, the pipe is just a marker and has not "achieved" the status of an artificial monument.

". . . 723.32 feet *to* a 1-inch diameter iron pipe; . . ." indicates, according to the intent of the writer, that the iron pipe is a artificial monument and that it, not the distance, is the controlling factor.

The exception to this "rule" occurs in cases in which real property boundaries are named in any part of the corner description. The mention of a real property boundary usually indicates the intention to limit the line at that real property boundary, even if calls for markers or other corner identification occurs first.

In any case, the order is not exclusive and binding. As with any part of the deed description, other evidence of intent may be used to refute a contention based upon order of appearance of corner descriptions. In areas where the custom of writing deed descriptions is well established and does not follow the pattern that is recommended here, it may require some time to introduce this method.

13.6.9. "That Same Point"

The corner to a real property parcel is a theoretical location that may refer to several physical or theoretical things to define that location. Any corner may have several different items in the list of these things. A corner may be monumented by a surveyor's marker, it may be part of a common boundary line, it may have several accessories, the SPC values may be known, or other features may need to be described.

The phrase "that same point" prevents the reader of a deed description from confusing the features of one corner with those of another. An example of the use of this phrase is ". . . to a stone borne located on the line between sections 30 and 31, *that same point* having the Virginia state plane coordinates (south zone) of $y = 234{,}543.55$ feet, $x = 1{,}323{,}445.39$ feet; thence, . . . "

13.6.10. "Point of Curvature" and "Point of Tangency"

There are two types of intersections possible between lines when one or both of the lines are curved. A line—even another curved line—may simply intersect with a curved line, or it may meet that curved line in a very special way, known as a "tangent" intersection. Figure 13.3 shows several combinations of intersections involving curved lines.

The situations labeled "tangent intersection," "compound curve," and "reverse curve" are all intersections where the radius center of the curve has a special relationship to the point of intersection. In the straight line tangent intersection (case 2), the radius center is located on a line from the intersection that is at right angles to the straight line. In the case of the compound curve and the reverse curve (cases 4 and 5, respectfully), the radius centers are on a straight line drawn through the point of intersection.

The occurrence of tangent intersections in deed descriptions can include the use of the phrase "point of curvature" when a straight line ends and a curved line begins or "point of tangency" when a curved line ends and a straight one begins.

The phrase "point of compound curvature" is used when a curved line of one radius intersects with a curved line of a different radius, but the same direction.

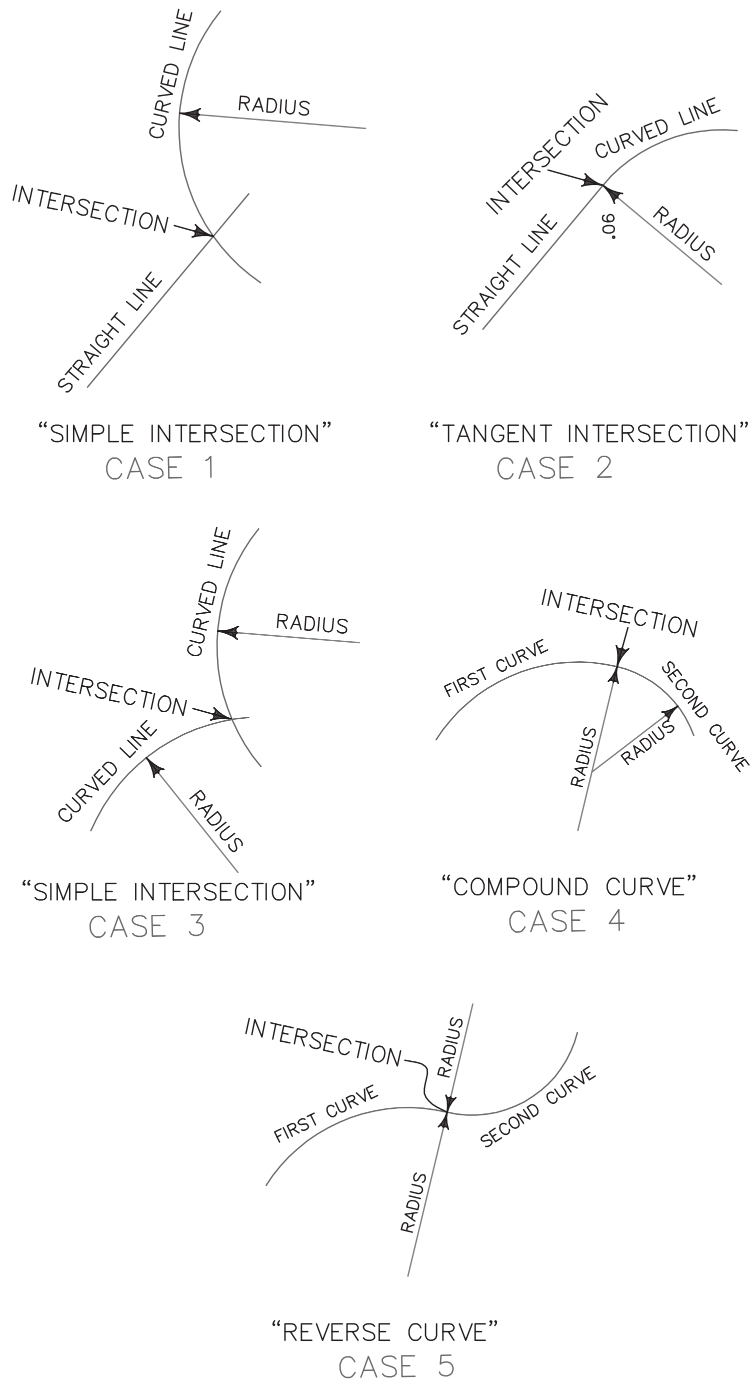

CURVED LINE
RADIUS
INTERSECTION
STRAIGHT LINE
"SIMPLE INTERSECTION"
CASE 1
INTERSECTION
CURVED LINE
90°
RADIUS
STRAIGHT LINE
"TANGENT INTERSECTION"
CASE 2
CURVED LINE
RADIUS
INTERSECTION
CURVED LINE
RADIUS
"SIMPLE INTERSECTION"
CASE 3
INTERSECTION
FIRST CURVE
SECOND CURVE
RADIUS
RADIUS
"COMPOUND CURVE"
CASE 4
INTERSECTION
RADIUS
FIRST CURVE
SECOND CURVE
RADIUS
"REVERSE CURVE"
CASE 5

FIGURE 13.3

The phrase "point of reversed curvature" is used when a curved line intersects with another line curving in the opposite direction at a point of tangency. Although all of the intersections discussed here occur at a point of tangency, the key phrase "point of tangency" is used in a deed description only when the description of a curved line ends at a point of tangency with a straight line.

These phrases are used only when there is a special orientation of circular curved lines with previous or subsequent lines and they are not used when simple intersections occur, such as cases 1 and 3 in Figure 13.3.

Some have argued that such "terms of art" should not be used in deed descriptions because most readers of the description do not know the definition of a tangent intersection. This may be true. However, the additional information provided by identifying tangent intersections is integral to the relationship of the boundaries and should not be omitted for fear that the reader is ignorant.

Readers who do not know terms in a deed description will consult a Land Surveyor or a dictionary and be educated. Deed descriptions that have important data excluded are incomplete and subject to possible misinterpretation.

13.6.11. "From Whence Bears" and "Distant"

The phrases "from whence bears" and "distant" are used exclusively to designate the location of accessories to a corner. The particular wording of the segments that describe accessories is deliberately "old-fashioned" so that accessory descriptions do not become confused with boundary line segments. For example, ". . . to an iron post *from whence bears* a large oak at north 23 degrees east and 23 feet distant, thence; . . ." makes the accessory a part of the deed description. In general, naming accessories in deed descriptions has not been routinely practiced.

13.6.12. "Encompassing an Area Of"

The phrase "encompassing an area of" should be placed directly after the second occurrence of the words "point-of-beginning" to emphasize that the area expressed is that of the entire parcel and does not account for any changes in area caused by the deletions or additions noted later in the deed description. For example, ". . . to the point-of-beginning; encompassing an area of 234.43 acres . . ." leaves no doubt that the narrative is intended to describe a parcel containing that area. If the statement of area is removed from the narrative portion of the deed description, then confusion can occur between area before and area after accounting for deletions or additions.

13.7. DELETIONS OR ADDITIONS

The deletions or additions portion of a deed description usually lists all of the easements, servitudes, rights-of-way, restrictions, or other modifications to the free, clear enjoyment of the parcel described.

Sometimes, more commonly in rural areas, this portion of the description actually entirely eliminates portions of the described tract from the deed. This practice can cause confusion and is becoming less common as local governments enact stricter and more formal codes or ordinances controlling the resubdivision of real property. The reader is urged to resubdivide and plat any deletion or addition to a parcel that completely changes all of the real property rights of that deletion or addition.

This deletions or additions portion of a deed description is clearly set apart from the narrative portion by the use of, in bold or capital letters, the heading “LESS THAN AND EXCEPT” “IN ADDITION” or “SUBJECT TO.”

These are not found in every deed description. Unfortunately, if this heading appears on a separate page from the narrative portion of the deed description, it may become separated from the rest of the deed documents. For this reason, it is recommended that the summation and references always follow the deletions or additions portion of the deed description. If this procedure is followed, the reader will always know that a complete deed description is present if a caption to the references is present.

Some examples of the use of deletions or additions in deed descriptions follow:

> **“Subject To:**
>
> A 5-foot easement adjoining and along the entire rear or northerly portion of the property for the purpose of installation and maintenance of a telephone cable . . . ”
>
> **“Subject To:**
>
> An easement of ingress and egress, 20-feet wide, adjoining and along the western boundary for the use of the owner of lot 3 and more particularly described as follows; . . .”

"Less Than and Except:

That portion of the property known as "Devils Well" and more particularly described as follows; . . ."

13.8. REFERENCES

The references portion of the deed description is used to "call for," thereby including in the deed, other documents, such as a survey plat, subdivision plat, maps, transactions, and the like. Items so included in the references will usually be considered as appearing in the deed description in full. A metes and bounds deed description *must* include a reference to the survey on which it is based.

A reference to a survey plat will normally have the effect of causing everything on the plat to become an integral and valid part of the deed. Sometimes the list of previous exchanges involving the parcel is also made in the references. Some examples of references follow:

"... and all as more fully described on the plat of survey by T. T. Thomas, P.L.S., dated February 2, 1986."

"... being the same property as acquired by the present owner from Sunshine Realty on December 4, 1944, and recorded in ..."

"... being the same property created by the subdivision plan of Oak Hills subdivision by T. Swift, L.S. and recorded in ..."

The purpose of a deed description is to express, clearly and as completely as possible, the intent of the parties conducting the exchange of title. Information that is relevant to that intent ought to appear in the deed description in one of the categories already mentioned.

A properly written deed description will provide courts that are called on to settle a boundary dispute the information necessary to eliminate deed discrepancies as an object of contention. A little extra time and effort in writing deed descriptions will benefit any assigns or heirs by reducing confusion and litigation.

A GUIDE TO UNDERSTANDING LAND SURVEYS
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CHAPTER 14

EXERCISES IN WRITING DEED DESCRIPTIONS

The following exercises in writing deed descriptions will present a sketch of a fictitious real property parcel, special conditions, and the author's recommended deed description. In reviewing the recommended deed description, you may wish to evaluate the survey plat using the checklist in Chapter 12 and note whether the description reflects the circumstances accurately.

14.1. CASE 1

Bill Wright, the owner of section 11, T22N R43W, Hog County, farm state, wishes to sell, to Mike Farmer, the "southeast 160 acres" of section 11. Figure 14.1 shows the only drawing of the section in Wright's possession. Wright acquired section 11 from Crystal Shine on November 10, 1942.

Farmer confirms that he wants to buy the "SE$^1/_4$ of Section 11" because he needs "a square plot 2,640 feet on a side." Of course, the "SE$^1/_4$," the "southeast 160 acres," and "a square plot 2,640 feet on a side" are three different divisions of section 11.

The deed description of the SE$^1/_4$ of section 11 can be made without a survey and would be "the SE$^1/_4$ sec. 11, T22N, R43W, Nth PM, Hog County, farm state and being a portion of the same property acquired by Bill Wright, the present seller, from Crystal Shine on November 10, 1942."

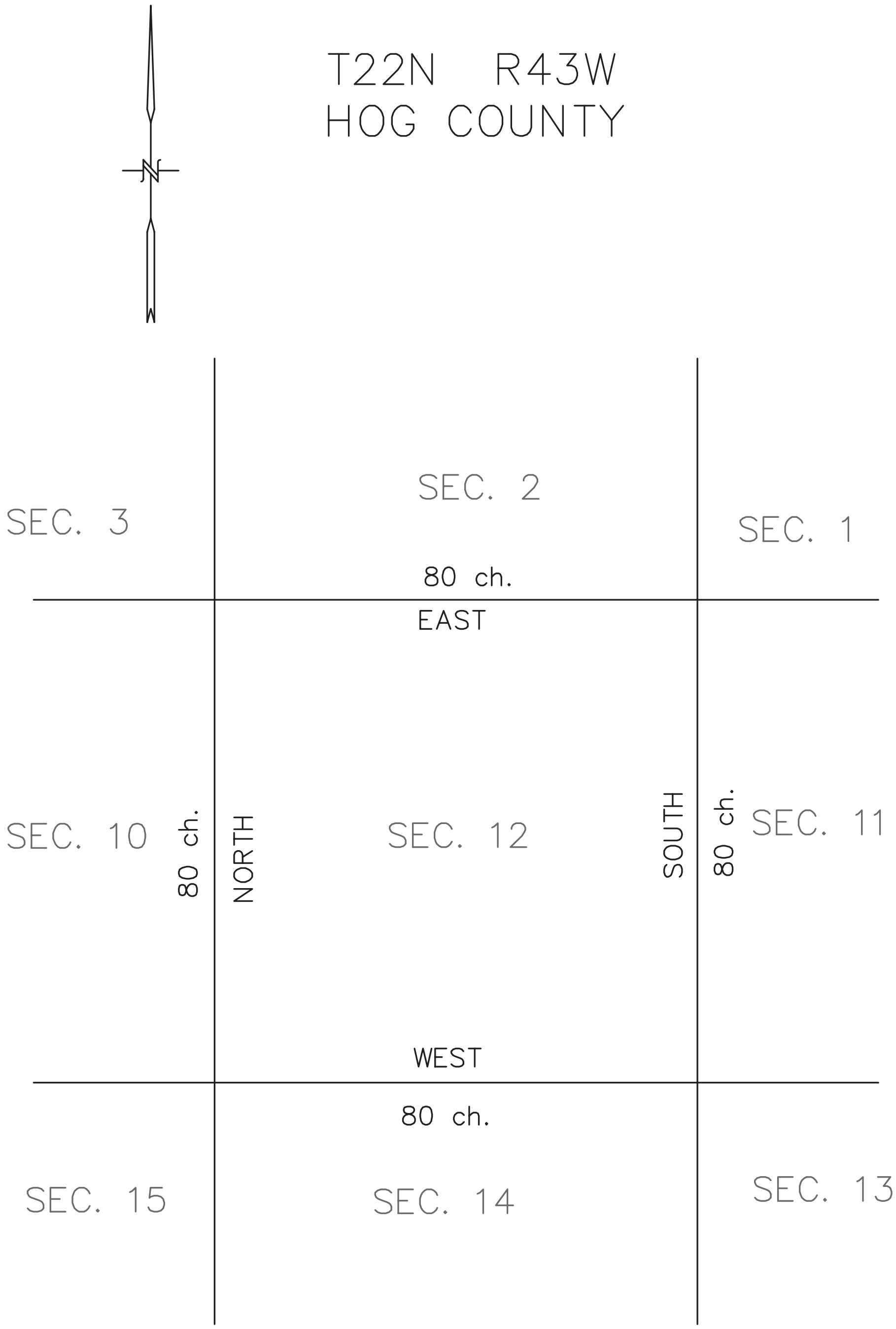
T22N R43W
HOG COUNTY
N
SEC. 2
SEC. 3
SEC. 1
80 ch.
EAST
SEC. 10
80 ch.
NORTH
SEC. 12
SOUTH
80 ch.
SEC. 11
WEST
80 ch.
SEC. 15
SEC. 14
SEC. 13

FIGURE 14.1

It would be quite improper to quarter section 11 based on the “ideal section” template and to add a narrative describing the SE$^1/_4$ as beginning at the section comer and measuring 40 chains (2,640 feet) to a side. If anything is certain about section 11, it is that the section is *not* 80 chains north, east, south, and west. Farmer wisely orders a survey of the SE$^1/_4$ of section 11. Figure 14.2 is a rendering of that survey.

An abstract of the deed record (title) does not indicate any recorded easements, servitudes or rights-of-way. The surveyor, Ben Round, reports that South Road was built and has been maintained by the local farmer’s co-op. The size of the right-of-way shown is based upon a written agreement on file at the co-op and is signed by Wright and others. Now the deed description can be written. Wright and Farmer both know exactly what is to be transferred. The description might read as follows:

> That parcel or portion of land designated as the SE$^1/_4$ of section 11, T22N, R43W, Nth PM, Hog County, farm state, and more particularly described as follows:
>
> Commencing and point-of-beginning at the southeast corner of section 11, that same point being monumented by a 6-inch square concrete monument; thence, in a westerly direction along the line between sections 11 and 14, that same line being the centerline of the South Road right-of-way, north 89 degrees 52 minutes 14 seconds west, a distance of 2,712.43 feet, to the southern quarter corner of section 11 and a 2-inch diameter iron pipe; thence, in a northerly direction along the line between the southeast quarter and the southwest quarter of section 11, north 0 degrees 42 minutes 12 seconds west, a distance of 2,688.21 feet, to the center of section 11 and a 1-inch diameter iron bar; thence, in an easterly direction along the line between the southeast quarter and the northeast quarter of section 11, south 88 degrees 02 minutes 48 seconds east, a distance of 2,592.34 feet, to the eastern quarter corner of section 11 and a 2-inch diameter pipe; thence, in a southerly direction along the line between sections 11 and 12, south 3 degrees 23 minutes 42 seconds east, a distance of 2,610.36 feet, to the point-of-beginning; encompassing an area of 161.02 acres:
>
> SUBJECT TO: a right-of-way, 40 feet in width, adjacent to, and along, the entire southern line of the property herein described, for the purpose of the maintenance of a roadway:
>
> All as more fully described on a plat of survey by Ben A. Round, land surveyor, dated June 3, 1988, and being a portion of the same property acquired by Bill Wright, the present owner, from Crystal Shine on November 10, 1942.

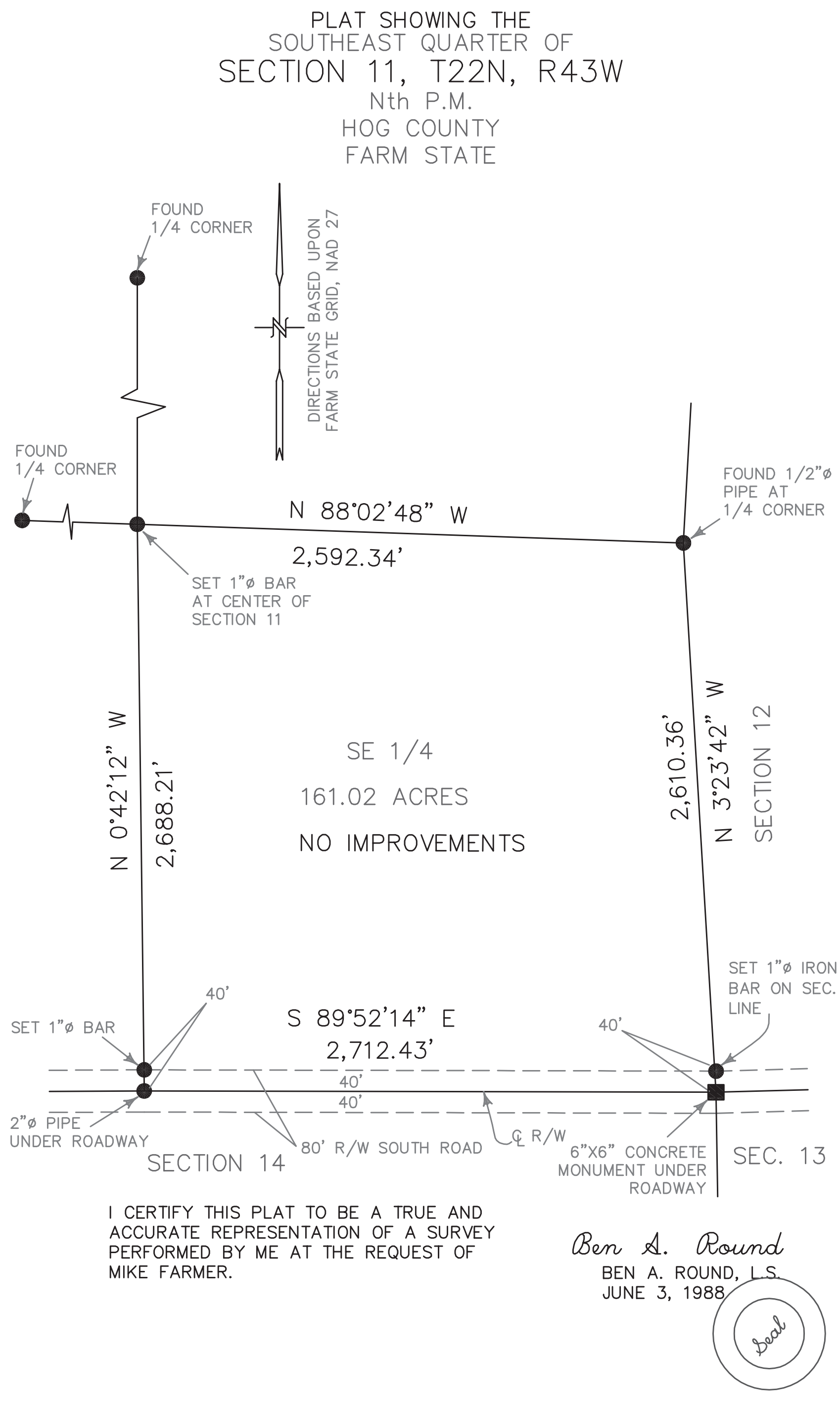
PLAT SHOWING THE
SOUTHEAST QUARTER OF
SECTION 11, T22N, R43W
Nth P.M.
HOG COUNTY
FARM STATE
FOUND
1/4 CORNER
DIRECTIONS BASED UPON
FARM STATE GRID, NAD 27
N
FOUND
1/4 CORNER
N 88°02'48" W
2,592.34'
FOUND 1/2"ø
PIPE AT
1/4 CORNER
SET 1"ø BAR
AT CENTER OF
SECTION 11
N 0°42'12" W
2,688.21'
SE 1/4
161.02 ACRES
NO IMPROVEMENTS
2,610.36'
N 3°23'42" W
SECTION 12
SET 1"ø IRON
BAR ON SEC.
LINE
40'
SET 1"ø BAR
S 89°52'14" E
2,712.43'
40'
40'
40'
2"ø PIPE
UNDER ROADWAY
SECTION 14
80' R/W SOUTH ROAD
℄ R/W
6"X6" CONCRETE
MONUMENT UNDER
ROADWAY
SEC. 13
I CERTIFY THIS PLAT TO BE A TRUE AND
ACCURATE REPRESENTATION OF A SURVEY
PERFORMED BY ME AT THE REQUEST OF
MIKE FARMER.
Ben A. Round
BEN A. ROUND, L.S.
JUNE 3, 1988
Seal

FIGURE 14.2

14.2. CASE 2

Iron Town, Bay County, Maryland, was created by a subdivision plan by S. Blake, county surveyor. The plan was dated May 3, 1920, and recorded in the Bay County conveyance office in book 5, page 2. Figure 14.3 shows a portion of that plan. Blake noted on the plan that "square corners were marked by a 2-inch diameter cast iron pipe." Write a deed description for lots 1 and 3, square "B."

The description of lot 1 might be as follows:

> That parcel of land designated as lot 1, square B, Iron Town subdivision, Bay County, Maryland and all as more fully described as follows:
>
> Commencing and point-of-beginning at the intersection of the northeasternmost right-of-way line of 33rd Avenue and the northwesternmost right-of-way line of Main Street, that same point being monumented by a 2-inch diameter cast iron pipe; thence, in a northerly direction along said northeasternmost right-of-way line of 33rd Avenue, north 51 minutes 07 minutes 46 seconds west, a distance of 170 feet, to the southeasternmost right-of-way line of the Westline Railroad, that same point being monumented by a 2-inch diameter cast iron pipe; thence, in an easterly direction along said southeasternmost right-of-way line of the Westline Railroad, north 34 degrees 47 minutes 06 seconds east, a distance of

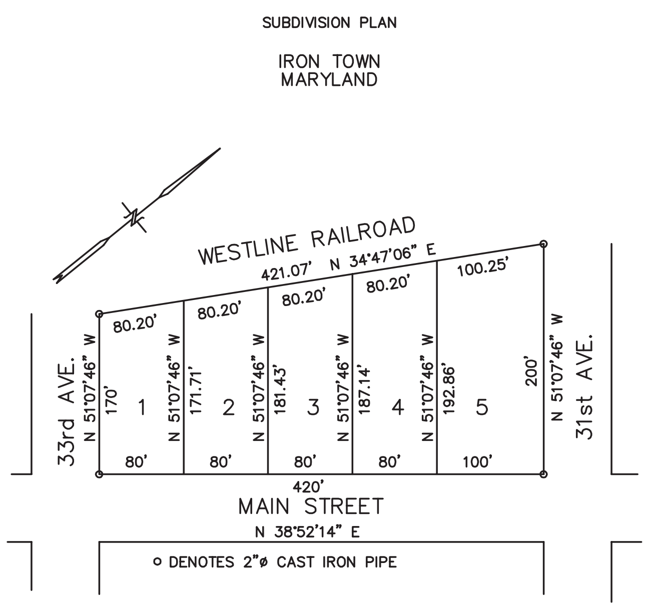

FIGURE 14.3

80.20 feet, to the line between lots 1 and 2; thence, in a southeasterly direction along said line between lots 1 and 2, south 51 degrees 07 minutes 47 seconds east, a distance of 175.71 feet, to the northwesternmost right-of-way line of Main Street; thence, in a southwesterly direction along said southeasternmost right-of-way line of Main Street, south 38 degrees 52 minutes 14 seconds west, a distance of 80 feet, to the point-of-beginning; all as more fully described on the plan of subdivision for Iron Town subdivision by S. Blake, county surveyor, dated May 3, 1920, recorded in book 5, page 2 of the Bay County conveyance office.

The description of Lot 3 might read as follows:

That parcel of portion of land designated as lot 3, square B, Iron Town subdivision, Bay County, Maryland, more particularly described as follows:

Commencing at the intersection of the easternmost right-of-way line of 33rd Avenue and the northernmost right-of-way line of Main Street, that same point being monumented by a 2-inch diameter cast iron pipe; thence, in an easterly direction along said northernmost right-of-way line of Main Street, north 38 degrees 52 minutes 14 seconds east, a distance of 160 feet, to the line between lots 2 and 3; thence, in a northerly direction along said line between lots 2 and 3, north 51 degrees 07 minutes 47 seconds west, a distance of 181.43 feet, to the southernmost right-of-way line of the Westline Railroad; thence, in an easterly direction along said southernmost right-of-way line of the Westline Railroad, north 34 degrees 47 minutes 06 seconds east, a distance of 80.20 feet, to the line between lots 3 and 4; thence, in a southerly direction along said line between lots 3 and 4, south 51 degrees 07 minutes 47 seconds east, a distance of 187.14 feet, to the northernmost right-of-way line of Main Street; thence, in a westerly direction along said northernmost right-of-way line of Main Street, south 38 degrees 52 minutes 14 seconds west, a distance of 80 feet, to the point-of-beginning; all as more fully described on the plan of subdivision of Iron Town subdivision, by S. Blake, county surveyor, dated May 3, 1920, and recorded in the Bay County conveyance office in book 5, page 2.

14.3. CASE 3

T. R. Grubb wants to give his son, R. T. Grubb, a portion of his farm property in Hardtack, Georgia. Figure 14.4 is a drawing, made by the senior Grubb, of the property to be conveyed. The Grubbs refuse to have a survey made on the property, because “Dem survey folks don’t know nuttin’. We gotta move dere markers every time dey come by.”

Write a description of the parcel conveyed.

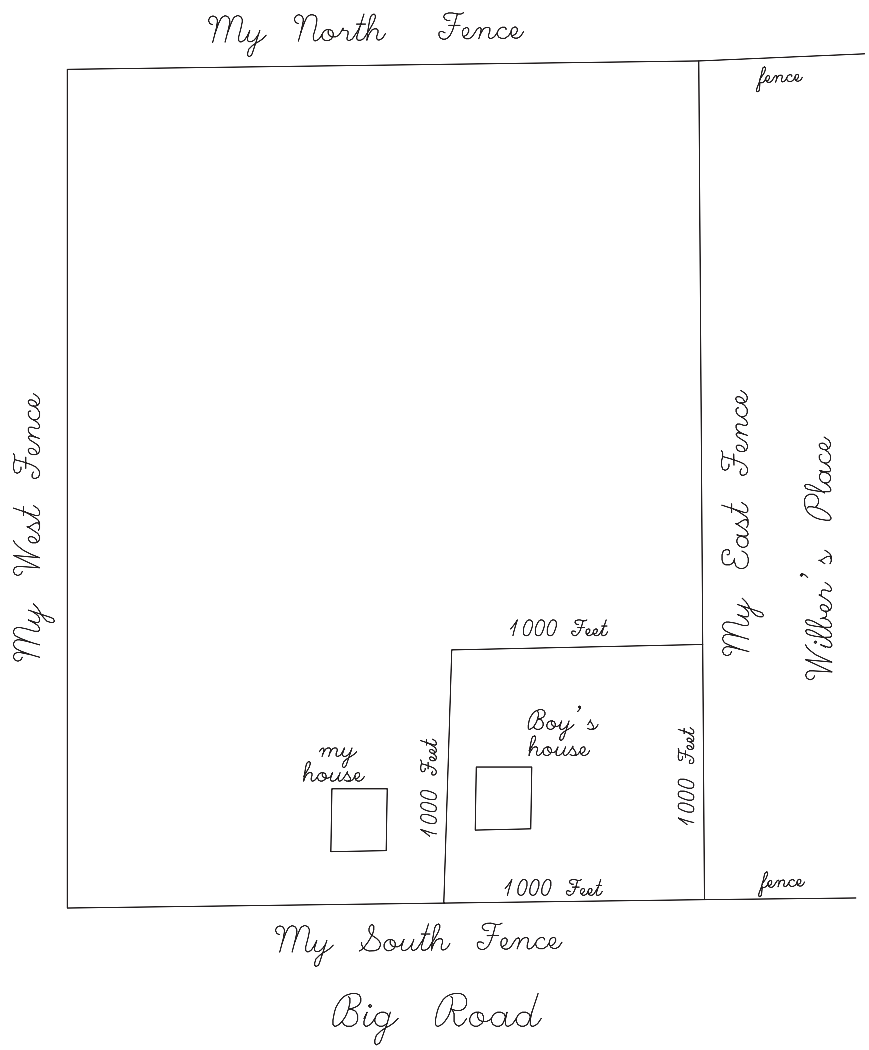

FIGURE 14.4

Perhaps a description of the son's parcel would be as follows:

That portion of land located in Hardtack, Hardtack County, Georgia, bounded on the south by Big Road, on the east by the property of T. T. Wilber, and on the north and west by the property of T. R. Grubb, and more particularly described as follows:

Commencing and point-of-beginning at the intersection of the westernmost fence line enclosing the property of T. T. Wilber and the fence line along

> the northernmost side of Big Road; thence, in a westerly direction along said northernmost fence line of Big Road, a distance of 1,000 feet, more or less, to an intersecting fence line enclosing the property herein conveyed; thence, in a northerly direction, along said fence line enclosing the property herein conveyed, a distance of 1,000 feet, more or less, to an intersecting fence line enclosing the property herein conveyed; thence, in an easterly direction along said fence line enclosing the property herein conveyed, a distance of 1,000 feet, more or less, to the westernmost property line of T. T. Wilber and a fence line; thence, in a southerly direction along said westernmost property line of T. T. Wilber, a distance of 1,000 feet, to the point-of-beginning; and all as more fully described on a sketch by T. R. Grubb, hereto attached.

This last exercise demonstrates that the absence of a recent land title survey and a proper subdivision plan does not prevent the creation of deed description that almost appears adequate. Unfortunately, the distances are doubtful, the angles at the corners are unknown, the corners are poorly monumented, the lines are dependent on possibly meandering fences, and the area is unknown. Pity the surveyor who, after 40 years and after the area has been cleared, is charged with the recovery of this particular parcel of land.

CHAPTER 15

ETHICS AND PROFESSIONAL CONDUCT

The Professional Land Surveyor's registration boards of most states have published codes of ethical conduct. Every Land Surveyor should obtain and be familiar with the codes of conduct published by each of the states where he or she is registered. Procedural rules and regulations along with certification requirements are generally similar for all states. The most common mandates are:

1. The Land Surveyor must be in responsible charge and perform adequate oversight and review of any work certified by him or her. (Certification of work done by others and not under his or her direct supervision is strictly prohibited).
2. The Land Surveyor shall avoid all conflicts of interest, fraud, misrepresentation, and all other dishonest activities.
3. The Professional Land Surveyor is required to maintain a high degree of competency in the practice of his or her profession. (Many states have adapted rules and regulations for required continuing education to maintain licensure as a Land Surveyor.)
4. The Land Surveyor must assure that all employees are well trained and properly supervised.
5. The Land Surveyor must exercise care and sound judgment in the exercise of professional services without regard to compensation. (Charity work must be afforded the same care and

professionalism as compensated projects. Contracts that have been underestimated cannot be "short cut" to meet the budget.)

6. In the event that blunders, discrepancies, or significant mistakes are discovered by the Land Surveyor, even if it involves his or her own work, the Land Surveyor shall immediately give notice of the situation to his or her client and/or others that may be impacted. The Land Surveyor shall conduct such corrective acts as may be required to mitigate the injury to others.
7. The Land Surveyor shall not undertake projects beyond his or her area of expertise.
8. The Land Surveyor shall not undertake projects beyond his or her resources.

Not all of the ethical bounds for the Land Surveyor are as obvious as the few preceding examples. Some exceptions follow.

15.1. CONFIDENTIALITY

The Land Surveyor should maintain the confidential nature of the Land Surveyor-client relationship. While not as binding as the lawyer-client or doctor-patient confidentiality, the Land Surveyor-client relationship is such that what is discovered during a survey performed for a client may be the property of the Land Surveyor, but it may not be disseminated without the permission of the client. The nature and volatility of real estate activity is such that property rights, land values, and business contracts can be adversely impacted if information provided to a landowner or financier were made public.

Of course, the knowledge of real property boundary locations and other conditions discovered by the Land Surveyor during any survey will be melded into the body of his or her experience and expertise and drawn on during other work.

15.2. PROFESSIONAL COURTESY

When requested, the Land Surveyor should provide such information as he or she may have pertaining to the location of real property boundaries to other Land Surveyors working in the vicinity. The greatest single cause of boundary disputes is the failure to obtain all of the information available concerning boundary locations. It is very rare for two Land

Surveyors, working from the same complete set of data, to arrive at different opinions as to the boundary locations. Land Surveyors who readily share information with others practicing in the area minimize the occurrences of boundary disputes.

15.3. IMPARTIAL EVALUATION

The Land Surveyor shall evaluate the evidence of boundary locations and other pertinent information without prejudice toward or against any party. The Land Surveyor is not to distort information or selectively consider facts with the intent to increase benefit to his or her client. Boundary decisions must be based on an impartial consideration of the evidence without regard to the identity of the landowners.

This impartiality extends to the witness stand. When employed as an expert witness, the Land Surveyor is expected to render his or her opinion based on the facts as he or she has developed them without consideration of the effects on the litigants. When employed as an expert, the Land Surveyor should avoid the concept of "their side" and "our side".

15.4. PROMOTE PROFESSIONALISM

The Land Surveyor is expected to exercise professional conduct at all times, both in the practice of the profession and in personal behavior. The Land Surveyor shall not participate in the denigration of another licensed Land Surveyor, nor attempt to supplant another Land Surveyor in a business relationship.

The Land Surveyor shall report any unprofessional activity or violations of the law, rules of the board, or rules of conduct to the appropriate authority.

The Land Surveyor shall council, tutor, or assist other Land Surveyors seeking to improve technical and professional skills.

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APPENDIX OF TABLES

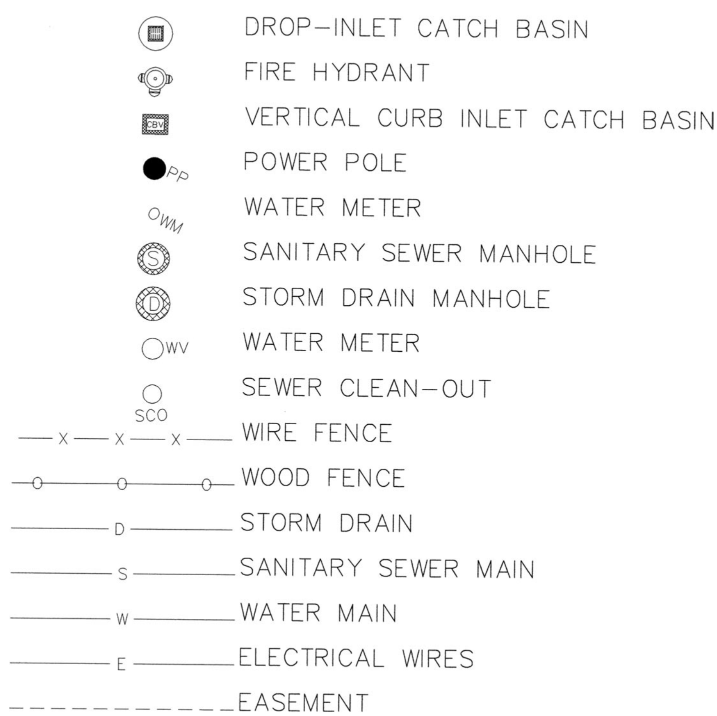

FIGURE A.1 Typical Map Symbols

TABLE A.1 Select Units of Linear and Square Measure

1 U.S. survey foot	$= \frac{1200}{3937}$ meters
1 U.S. standard foot	= 0.3048 meters
1 line	$= \frac{1}{8}$ inch[a]
1 foot	= 12 inches
1 yard	= 3 feet
1 rod, pole, perch	$= 16\frac{1}{2}$ feet[b]
1 chain	= 66 feet
1 chain	= 100 links
1 chain	= 4 rods, poles, perches
1 mile	= 80 chains
1 mile	= 5,280 feet
1 nautical mile	= 6,080.27 feet[c]
1 rood	$= \frac{1}{4}$ acre
1 acre	= 43,560 square feet
1 acre	= 10 square chains
1 square mile	= 640 acres
1 compass, row	= 6 feet[a]
1 French foot	= 1/180 arpent
1 toise	$= \frac{1}{30}$ arpent
1 toise	= 6.3944 feet[a]
1 arpent	= 191.994 feet (GLO definition)
1 arpent	= 191.83 feet
1 arpent square measure	= 0.8448 acres[a]
1 vara	$= 33\frac{1}{3}$ inches[a]
1 hand	= 4 inches
1 span	= 9 inches
1 cubit	= 18 inches
1 step	$= 2\frac{1}{2}$ feet[a]
1 pace	= 5 feet[a]
1 fathom	= 6 feet
1 furlong	= 10 chains
1 league	= 3 miles[a]

[a]These units may vary greatly, depending on local custom.
[b]Feet listed in this table are U.S. survey feet, unless otherwise noted.
[c]This distance is a function of the spheroid in use and will vary. Some report this distance as 6,076.10 feet.

TABLE A.2 Common Angular Units of Measure

1 circle	= 360 degrees
1 circle	= 400 grads
1 circle	= 32 points
1 circle	= 6,400 mils
1 degree	= 60 minutes
1 minute	= 60 seconds
1 degree of arc	= 17.45 feet in 1,000 feet[a]
1 minute of arc	= 0.29 feet in 1,000 feet[a]
1 second of arc	= 0.005 feet in 1,000 feet[a]
1 second of latitude at the equator	= 101 feet[a]
1 minute of latitude at the equator	= 6,046 feet[a]

[a]Approximate distance only.

TABLE A.3 Accuracy Specifications and Positional Tolerances

	A	B	C	D	
Condition	Urban	Suburban	Rural	Mountain or Marshland	
Unadjusted closure (maximum allowable)	1:15,000	1:10,000	1:7,500	1:5,000	Traverse loop or between control monuments
Angular closure (maximum allowable)	10″ N	15″ N	25″ N	30″ N	N = number of angles in traverse
Accuracy of bearing in relation to source (maximum allowable)	± 15 sec.	± 20 sec.	± 30 sec.	± 40 sec.	1/sine angle = denominator in error of closure (approximately)
Linear distances accurate to: (maximum allowable)	± 0.05 ft. per 1,000 ft.	± 0.1 ft. per 1,000 ft.	± 0.15 ft. per 1,000 ft.	± 0.2 ft. per 1,000 ft.	Sine angle × 1,000 (approximately) where = accuracy of bearing
Positional error of any monument (maximum)	.03′ + AC/15,000	.05′ + AC/10,000	.07′ + AC/7,500	.1′ + AC/5,000	AC = length of any course
Calculation of area—accurate and carried to nearest——decimal place of acre	.0001	.0001	.001	.001	To 1 acre
	.001	.001	.01	.01	To 10 acres
	.01	.01	.1	.1	To 100 acres
	.1	.1	.2	.3	To 1,000 acres
Elevations for boundaries controlled by tides, contours, rivers, etc., accurate to:	± .03 ft.	± .05 ft.	± 0.1 ft.	± 0.2 ft.	Based on accepted local datum

(*Continued*)

TABLE A.3 (***Continued***)

Condition	A Urban	B Suburban	C Rural	D Mountain or Marshland	
Location of improvements, structures, paving, etc. (tie measurements)	± 0.1 ft.	± 0.2 ft.	± 0.5 ft.	± 1 ft.	
Scale of maps sufficient to show detail but no less than	1″ = 200’	1″ = 400’	1″ = 1,000’	1″ = 2,000’	
Positional error in map plotting not to exceed: (applies to original map only)	5 ft.	10 ft.	25 ft.	50 ft.	Generally $\frac{1}{40}$th inch; national map accuracy calls for $\frac{1}{50}$th inch
	1″ = 200’	1″ = 400’	1″ = 1,000’	1″ = 2,000′	
Adjusted mathematical closure of survey (minimum)	0.03′ or 1:50,000	0.05′ or 1:50,000	0.07′ or 1:50,000	0.1′ or 1:50,000	Larger value allowed

TABLE A.4 Typical Instrument Precisions

Type of Instrument (Typical)	Smallest Unit Directly Read	Direct Read Uncertainty in 1,000 Feet
Marine compass	$11\frac{1}{4}$ degrees	196.0 feet
Surveyor's compass	15 minutes	4.4 feet
Builder's transit	1 minute	0.29 feet
Mountain transit	30 seconds	0.15 feet
Surveyor's theodolite	10 seconds	0.05 feet[a]
Control survey theodolite	1 second	0.005 feet[a]
Electronic distance meters	0.01 feet	0.03 feet[a]

[a]The errors involved with pointing and centering of target and instrument are much greater than the minimum direct read of the instrument itself.

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GLOSSARY OF SELECT TERMS

(These definitions are condensed)

Abstract of title (or deed) A summary of conveyances, exchanges, easements, or other legal instruments affecting the property rights of a particular parcel.

Accessories to a corner Natural physical objects, such as trees, rock formations, ledges, and other features, that are at a known distance and/or direction from a corner. Accessories are part of the corner monumentation.

Adjoiner That parcel of land that shares a common boundary with another.

Adjusted value The value assigned to a measured quantity after the application of corrections designed to account for measurement errors.

Aliquot parts A division of a USPLS section following a specified procedure.

Angle A measure of the relationship of two intersecting lines.

Area The measure of the bounded surface formed by the intersection of real property boundaries and a particular vertical datum.

Astronomic Values assigned to direction or position based on measurements made of the relative positions of heavenly bodies.

Azimuth A definition of the direction of a line based on the clockwise angle formed between that line and a certain pole of a meridian.

Balancing a traverse A procedure, or procedures, for distributing the accumulated measurement errors of a traverse among the observed values in order to obtain computational consistency.

Baseline A series of points established for the expressed purpose of locating other features or lines.

Bearing A definition of the direction of a line based on the clockwise or counterclockwise angle formed between that line and either pole of a meridian.

Benchmark An object, natural or artificial, in a relatively stable location, that is at a known elevation relative to a particular vertical datum.

Blunder A mistake or an incorrect assessment of a measured value associated with a gross misinterpretation of facts.

Boundary line An imaginary line of demarcation between two adjoining land parcels, distinguishing a separation of real property rights, which may or may not be physically marked.

Bureau of Land Management (BLM) An agency of the U.S. government, formerly known as the Government Land Office (GLO), which is responsible for the survey of public lands, among other things.

Cadastre An official map of a political region delineating size, location, ownership, and land values for the purpose of assessing taxes.

Center of a section A point in a USPLS section determined by the intersection of two straight lines drawn between opposing quarter corners.

Chain (1) A length of measure equal to 66 U.S. survey feet; (2) a surveyor's measuring tape; (3) the act of measuring a linear distance.

Chord A straight line drawn between the ends of a curved line segment.

Compass (1) A device for detecting the earth's magnetic field and aligning with the lines of force; (2) a device for laying out a specific distance or marking an arc; (3) a unit of measure, usually defined as 6 feet.

Contour A series of lines on a map connecting points of equal elevation.

Control A series of vertical and/or horizontal survey marks, data, measurements, maps, photographs, or other acts specifically performed to serve as the foundation or datum for future surveys.

Coordinate system A method of identifying a particular point in two or three dimensions by a systematic listing of the distances from defined baselines or origins.

Corner A point of intersection of real property boundary lines, which may or may not be monumented.

Course The direction of a line segment. In some states, the course also includes the length of a line segment.

Datum A basis or measurement foundation on which a location can be defined or referenced either vertically, horizontally, or both.

Deed A written instrument that conveys rights or interests in real property.

Deed description That part of a deed that identifies and describes the relevant real property parcel.

Departure The change in the distance from a meridian experienced in moving from one end of a line segment to another.

Easement A right held by one party to the land of another.

Electronic distance meter (EDM) A device that measures distances by the use of electromagnetic radiation.

Elevation The distance above or below a vertical datum.

Equator (1) Zero degrees latitude; (2) an imaginary plane passing through the earth and perpendicular to the axis of rotation.

Error The difference between the measured and actual values for a certain quantity.

Error of closure The failure of the result of a set of measured values to agree mathematically with the theoretical result.

Fee simple Unlimited rights of real property ownership restricted only by the laws of the United States, state, and local governmental jurisdictions.

Field notes The written notes, sketches, and computations of a surveyor taken during and at the site of a survey.

Geoid A theoretical surface that is everywhere perpendicular to plumb at every point.

GIS (Geographical Information System) A database and information recovery system indexed by location.

Government Land Office See Bureau of Land Management (BLM).

GPS (Global Positioning System) A network of radio transmitting navigational satellites and specialized receivers used to determine the geodetic location of the receiver.

Grade The slope of a surface or structure.

Grid An imaginary network of evenly spaced parallel and perpendicular two-dimensional lines.

Horizontal A plane, perpendicular to the plumb line at a particular point.

Land description The exact location of a real property parcel in terms of the controlling land record system.

Legal description The description of a real property parcel sufficient to identify that parcel uniquely without oral testimony.

Latitude (1) The distance along a meridian; (2) the north or south change in distance experienced in moving from one end of a line segment to another.

Level (1) A surface that is everywhere perpendicular to plumb; (2) an instrument for measuring differences in elevation.

Line A series of contiguous points forming a vertical geometric surface and extending from the center of the earth up through the land surface and into space.

LIS (Land Information System) A database of information related to the land.

Longitude The distance between two meridians.

Map A graphic, two-dimensional representation of the surface of the earth.

Map projection A systematic method, accounting for the curvature of the earth, that mathematically reduces surface location information into two-dimensional data.

Mean sea level (MSL) The average elevation of the sea over a 19-year period. MSL is often confused with the North American Vertical Datum (NAVD).

Measurement An estimation of a quantity or a distance based on the systematic application of a standardized procedure or device.

Metes and bounds description A description formed by sequentially reciting the courses and adjoiners of a real property parcel.

Meridian A north–south line used to reference lines of a survey.

Monument The physical object that indicates the location of a point, station, or real property corner.

More or less A phrase indicating a crude or uncertain value for a quantity.

National Geodetic Survey (NGS) The agency of the U.S. government that is responsible for development and maintenance of benchmarks and stations for navigation and mapping.

National Geodetic Vertical Datum, 1927 (NGVD) A vertical datum established by the National Geodetic Survey in 1927 that defined elevations published for use on federal maps and regulations, now obsolete.

North Aligned with the axis of the earth's rotation and in the direction of that particular pole designated as "north."

North American Datum 1983 (NAD 83) The horizontal datum established by the National Geodetic Survey to define geodetic positioning for navigational and mapping purposes.

North American Vertical Datum, 1988 (NAVD 88) The vertical datum established by the National Geodetic Survey that defines elevations published for use on federal maps and regulations and replaced NGVD.

Observation The noting of a condition, which usually is the result of an act of measurement.

Plane A flat surface such that the shortest route between any two locations on the surface is entirely contained within the surface.

Plat A map, prepared by a land surveyor, usually for a specific legal purpose.

Plumb Aligned with the pull of gravity.

Platted subdivision description A description based on a map or plan, usually recorded, identifying a real property parcel by the letter or number designation found on that map or plan.

Point (1) A specific location; (2) a vertical geometric ray (line) originating at the center of the earth and extending up through the surface into space.

Point-of-Beginning The first point encountered in the narrative portion of a deed description that is a part of the real property boundary itself.

Point-of-Commencement The first point described in the narrative portion of a deed description that is well known and used to direct the reader to the location of the real property. The commencement point may not be a point on the real property boundary being described.

Point of compound curvature A point on a circular curved line at which a curve of one radius length ends and a curve of another radius length begins, and occurring at a point on the extension of a straight line drawn between the two radius centers.

Point of curvature A point at which a straight line begins a circular curve and is at right angles to the radius of the curve at that point.

Point of reverse curvature A point on a curved line, occurring on a line drawn between the radius centers, at which a curve in one direction ends and a curve in the opposite direction begins.

Pole *See* Rod.

Quarter corner That corner, set by the government surveyor, between section corners.

Random error Incidental errors occurring as a result of observational imprecision.

Random traverse A traverse in which the location of stations is chosen for accessibility and inter-visibility and does not have a constant relationship to any real property boundaries.

Range line A north–south line used to divide public lands.

Recovered corner A real property corner that has been verified by the discovery of the original monument, accessories, or other physical evidence.

Right-of-way Land granted (usually to the governing authority) by deed, servitude, or easement for the construction of an infrastructure. Rights-of-way may grant limited property rights or full property rights.

Riparian Pertaining to the banks of a body of water.

Rod (1) $16^1/_2$ feet; (2) a wooden pole (rod) being 16.5 feet long and used to measure horizontal distances.

Section The smallest division of land monumented by the U.S. government public lands for sale.

Servitude *See* Easement.

Spiral curve A curved line of constantly varying radius.

Station A point established by survey procedures used to determine the location of other features.

Straight line A vertical plane containing the center of the earth. A line established by the line of sight between two points.

Surface The separation of two distinct spaces. The interface between the earth and the atmosphere.

Land surveying The art and science of measuring, marking, recovering, and mapping the relative positions or locations of terrain features and real property boundaries.

Systematic error Errors occurring consistently, regularly, and of the same algebraic sign as the result of a measurement condition.

Theodolite An instrument designed to measure precisely vertical and horizontal angles.

Title The exclusive right to the use and enjoyment of a particular parcel of real property.

Township A division of public lands generally 6 miles wide and 6 miles long and containing 36 sections.

Township line An east–west line used to divide public lands.

Transit In the United States, a transit is a theodolite having a vernier read scale for measuring horizontal and vertical angles and having a scope that is capable of being inverted.

Traverse A systematic series of stations in which the direction and length of line segments formed by consecutive stations is measured.

Vernier An etched ruler or scale that is marked such that, when it is aligned with another ruler or scale, divisions much smaller than marked on either scale can be read directly.

Vertical Aligned with the pull of gravity.

Witness mark A physical feature that is at a known distance and direction from a corner.

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