Which Way is North?

by Albert J. Hebrank, PLS

EARLY IN MY SURVEY career while starting a boundary survey in Ballard (a Scandinavian neighborhood in Seattle), I was standing on the sidewalk studying the legal description and the city quarter section map to ascertain to what meridian the description referred when a long-time resident of the neighborhood approached me and asked what I was doing. When I replied that I was trying to determine which way was north, he fixed me with a pitiful gaze, pointed up the avenue, and said "I only ban here forty yars, but north ban that–a–way," and wandered off shaking his head. Unfortunately he had not held the pose long enough for me to make an instrument observation along his forefinger, so I was forced to rely on survey interpretation rather than upon his positive knowledge.

Those of you who work with maps and property descriptions and title reports, and you know what north is. You know that it is usually shown on maps with an arrow, and if no arrow is shown, the default position is generally straight up the sheet. You also know that directions based upon the four points of the compass and intervening positions appear in many property descriptions and show an angular relationship between courses. I suspect that many of you also request survey work on occasion and may specify what meridian is to be used in those surveys. And many more interpret or prepare property descriptions which use these directions.

Have you ever noticed that a single line on the county tax assessor's map, for example, may have three or four different directions noted along its length? Or that two adjoining descriptions may have different bearings called along what is presumably a common line? Can all be correct? How did this come about?

Let's take a look at how and why a surveyor uses bearings in ascertaining the geometry of a relatively small parcel of land, "relatively small" meaning sizes of normal ownership as opposed to sizes involved in the mapping of entire cities or counties.

All such land parcels are geometric figures which are defined on a plane surface by angles and distances, as is shown in Figure 1. Even curvilinear figures can be reduced to triangular segments such as you in Figure 2. In order to be certain that the described figure is mathematically correct, or "closes,"as the surveyor says, you check this collection of triangles, one against the other, to see that all dimensions are compatible from one triangle to the next.

But there is an easier way illustrated in Figure 3. If you calculate the triangles enclosing the figure based on the direction of one line of the figure, in this case the one along the left side, you find yourself dealing only with right triangles and no longer have to deal with pesky formulas such as the law of sines or the law of cosines. Also the veracity, or mathematical integrity of the figure is proven if the algebraic sum of all of the "vertical" components is zero and the algebraic sum of all of the "horizontal" components is zero.

In Figure 4, we take this concept one step farther and relate the figure to a pair of axes set perpendicular to each other, and calculate the positions of the various points relative to the point where the two axes intersect. This intersection point is referred to as the origin of the system. Mathematicians would refer then to the position of any point in the figure as being at coordinates x and y; x being the distance along the x-axis from the origin, and y being the distance along the y-axis from the origin. The surveyor prefers to call distances along the y-axis "north" and distances along the x-axis "east." This method of calculation is known as coordinate geometry.

The important concept here is that so long as the axes are constructed perpendicular to one another, their direction relative to the figure is of no importance in the calculations. Therefore, the base direction of the controlling line in the figure may be related to a recognized coordinate system, or it may relate to some other record direction of the line such as the Public Land Survey System or to a plat or to an old deed or a deed being retraced or to a celestial observation or to a recognized map projection, or it may simply be assumed.

A mix of these different "bases of bearings" often accounts for the different directions along the same lines seen

on many maps. So long as the base direction is described in the deed or plat, the figure can be computed relative to that document. However, mixing of bearing systems obviously does not work and has resulted not only in confusion over boundary line locations, but even in lawsuits often brought about by the need to ascertain the intent of the author of the description.

You may have noticed that I just skipped very lightly into the use of the term "bearing". Let us look now at Figure 5, which illustrates just what a bearing is. If you construct these same axes just discussed, and then draw some straight lines in random directions through the origin, you can see that the bearing of a line is the angular direction measured from the north–south axis toward the east–west axis. In other words, the bearing north 60 degrees east defines a line that makes an angle of 60 degrees in a clockwise (easterly) direction from north. Similarly, a bearing of south 45 degrees east defines a line that makes an angle of 45 degrees in a counterclockwise (easterly) direction from south. As the directions north and south from the same point of origin define the very same line, but going in opposite directions, so do the bearings north 60 degrees east and south 60 degrees west, and either notation is correct to describe the aspect of that line, although not its absolute direction. This is true of all bearings of the same numerical value that are in opposing quadrants (i.e., northeast and southwest or northwest and southeast).

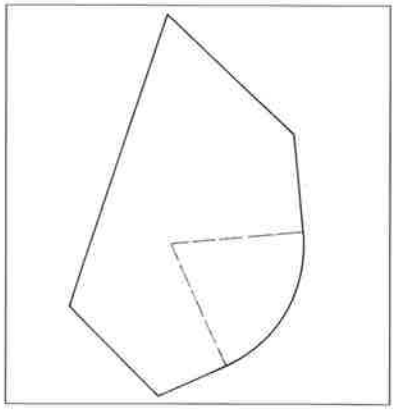

Figure 1

In the lower portion of Figure 5 appear two other directional systems often used by surveyors, although seldom in property descriptions. These are known as "azimuth" notation and work the same as bearings except that rather than showing angular direction in quadrants of 90 degrees each, angles (azimuths) extend through the full 360-degree circle and are always measured in a clockwise direction, north azimuths having zero degrees equals 360 degrees at the north position and south azimuths having zero degrees equals 360 degrees at the south position. Azimuths are often used in the calculation of coordinates because of the relative ease of addition and subtraction of angles within this system.

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The terms "true north" and "magnetic north" are often encountered in requests for surveys and/or mapping specifications. To understand what these terms mean, one must understand the configuration of our planet earth, the location of the north magnetic pole, and map projections often used in surveying and mapping practice.

Contrary to the expressed beliefs of a famous society located in Great Britain, consensus has it that the earth is not flat. While the best generally available map of the earth is a globe, spherical in shape, it is not truly a sphere either. The proper term for the actual shape of the earth is geoid, which can be closely ap-