GPS AND BOUNDARY RETRACEMENT

by
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INTRODUCTION

Much has been written about applying GPS to surveying. At relatively low cost, GPS provides a reliable means to get both relative and absolute positional information. The low cost of the technology has lead to a proliferation of GPS receivers, making this technology common not only among scientists and surveyors but also hunters, hikers, campers, fishermen, and landowners. Unfortunately, the proliferation of receivers has often resulted in the misuse of the technology in locating boundaries. This article will discuss some of the problems that occur and advantages gained in applying this technology to boundary retracement.

HISTORICAL SURVEYS

To understand the problems with using GPS in boundary retracement, knowledge of past survey practice is necessary. The early surveyors used the compass and chain and later the transit and tape in establishing many of today's boundaries. Land was inexpensive. Training was haphazard. Obstacles in the path of the survey were many. Virgin forests, wild animals, hostile Indians, and swarms of insects, to name a few, all took their toll of the surveyor's attention to his work. The chain and tape were unwieldy and inexpertly employed. Slope measurements were sometimes the norm. Correcting the chain and tape for sag, temperature differences, and stretching was seldom done. Magnetic readings were often erratic or failed to account for local attractions and diurnal variations. As a consequence, inconsistencies and errors in measurements were so common in early surveys that measurements were not held in high regard.

> The science of geometry and mathematics is exact. The infinite depths of stellar space are measured with such exact nicety that the position of stars and planets can be calculated to the fraction of a second of time ... How can it be that in the ascertainment of one line of so small an area, bounded by four lines only, a difference of from 8 to 24 feet arises? It is evident that the methods pursued, and not a defective science, have brought about the different results, different maps. (Warren v.

Boggs, 90 W.Va. 329, 332, 111 S.E. 331 (1922))

> The science of mathematics is exact, but the different results reached in its application by different surveyors, is sometimes startling to the layman, when applied to what appears to be an ordinary survey. (Zirkle v. Three Forks Coal Company, 103 W.Va. 614, 626, 138 S.E. 371 (1927))

RULES OF CONSTRUCTION

To resolve ambiguities between what was marked and what was measured, the courts adopted rules, known as principles or rules of construction, that are meant to be applied in a consistent manner where there is conflicting information. One rule that is a fundamental principle in retracing a boundary is that the retracing surveyor is charged with following in the footsteps of the original surveyor. The original boundary fixed by the original surveyor, as imperfectly as the boundary may have been measured and documented, remains the boundary.

MEASUREMENTS AND LIMITATIONS

In adherence to this fundamental principle, the courts have held that original monuments or the former location of the monuments are superior to measurements in determining the location of boundaries. Research and field reconnaissance are often more important than the precision of measurements in locating the position of the original monuments. Put in other words, the gathering and reduction of measurements, while important, is seldom a persuasive factor or a critical aspect of boundary retracement. Lines of occupation, witness marks, and memories of the elderly are more compelling than the measurements. It is often disconcerting to the non-surveyor to be told that in fixing old boundaries, the law favors the old hedge that meanders several meters off a straight line rather than sophisticated equipment that can measure to the nearest centimeter. These concepts are well stated by the Ohio court in Sellman v. Schaaf:

> The primary function of the second surveyor is to find first where the boundaries were established by the first surveyor … The essential rule governing the resurvey is to follow the steps of the first surveyor. ... Conveyances are presumed to be made according to a prior actual survey. It is said that the primary purpose of construction is to follow the footsteps of the surveyor on the ground. ... A survey is the locating and marking on the ground of the land described in a grant. Once a tract has been

> located by survey, and its boundaries have been marked, those boundaries cannot be altered by a subsequent survey. In making a resurvey, the duty of the surveyor is merely to locate the monuments placed by the original surveyor, or, where such monuments no longer exist, the places where they originally stood. ... All lands are supposed to be actually surveyed, and the intention of the grant is to convey the land according to the actual survey. It is therefore said that the real purpose of a boundary inquiry is to follow the steps of the surveyor on the ground, and all calls will be construed with this in mind. ... It has been declared that all the rules of law adopted for guidance in locating boundary lines have been to the end that the steps of the surveyor who originally projected the lines on the ground may be retraced as nearly as possible; further, that in determining the location of a survey, the fundamental principle is that it is to be located where the surveyor ran it. Any call, it has been said, may be disregarded, in order to ascertain the footsteps of the surveyor in establishing the boundary of the tract attempted to be marked on the land; and the conditions and circumstances surrounding the location should be taken into consideration to determine the surveyor's intent. ... The original survey must govern if it can be retraced. It must not be disregarded. So, too, the places where the corners were located, right or wrong, govern, if they can be found. In that case a hedge planted on the line established by original survey stakes was better evidence of the true line than that shown by a recent survey. In making a resurvey it is the surveyor's duty to relocate the original lines and corners at the places actually established and not to run independent new lines, even though the original lines were full of errors.
> (Sellman v. Schaaf, 26 Ohio.App.2d 35, 41-43, 269 N.E.2d 60, 65-66 (1971))

As the precision of measurements increase, the accuracy decreases. (In the context of this article, precision refers to the repeatability of the measurements while accuracy refers to the correlation with the original boundary.) In many boundary retracement surveys, there is an indirect correlation between precise measurements and accurate measurements. Precise measurements become less useful in finding the position of original corners than more imprecise measurements that better replicate the original measurements. Measurements that replicate the deficiencies of the original equipment are more accurate in locating the original bounds than precise measurements that remove or are not influenced by local magnetic anomalies and terrain conditions between two points on the earth’s surface.

With these articulations in mind, a person probably has a better chance of successfully retracing the original location of an ancient boundary using a compass and chain rather than a GPS receiver — if the chain and compass were used to establish the original boundary. The reason is that a compass and chain will likely incorporate all the local attractions and imprecisions inherent in the work of the original surveyor. Using the compass and chain, the retracement surveyor will be

closer to the lines marked by the original surveyor (i.e., the original surveyor's footsteps).

Consider an example to illustrate these concepts. Two people attempt to locate the same property boundary. The first uses a plastic tape and compass to locate approximate corner locations, wanders about, and finds the old remains of stakes set by the original surveyor. In subsequent measurements, the first person makes a series of imprecise and even faulty measurements between the stakes. The first person subsequently documents these faulty measurements on a plan depicting the boundary. A second person using GPS equipment makes a series of precise measurements to reestablish the boundaries according to the measurements found in the deed. Not realizing that old measurements found in deeds often contained errors in feet and sometimes hundreds of feet, the second person goes about marking off the deed measurements with a precision unknown in the past. Unable to find the original stakes or thinking them set in error, the second person marks corners according to the precise measurements they have obtained with the GPS receiver. The second person produces a plan showing precise measurements between the corners set. As between the two, the courts would find that the first person has performed a more accurate survey according to the legal rules applicable to boundary retracement.

It follows that the ability to replicate with great precision the nominal measurements in the deed and project them upon the ground with GPS technology is seldom the best way to retrace old boundaries. Accordingly, the proliferation of GPS receivers in the hands of laypersons lacking a knowledge of the legal rules of construction does not make the layperson any more qualified to locate the boundary than placing an X-ray in the hands of a layperson makes a layperson qualified to give a medical opinion on the condition of a patient.

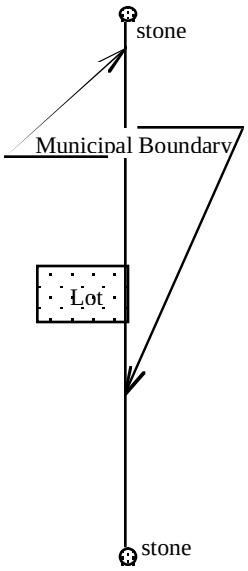
GEODETIC V. PLANE SURVEYING

Another problem that GPS appears to thrust upon both layperson and surveyor alike is what can be termed the "geodesy" factor. The ancient boundary measurements were more times than not slope distances measured by laying the chain on the ground or roughly elevating the chain to avoid the natural debris and litter found upon the ground surface. More recent boundary measurements use distances merely corrected to local horizontal. GPS measurements, on the other hand, produce vectors between co-observing stations lending a natural preference to a three-dimensional mathematical approach. The length of the vectors could be reduced to the ellipsoid or the conformal mapping plane. In some areas, the differences between these derived GPS measurements and local horizontal distances could be considerable.

MISSING EVIDENCE

GPS technology in the hands of surveyors often cause the surveyor to forsake a thorough search for evidence along the boundary. When a surveyor employs a compass and tape or has to traverse along or near a boundary, the surveyor often discovers a great deal of evidence that helps locate the position of the original boundary. Old stone walls, ancient blazes on trees, rusted remains of wire fence, support stones for the split rail fence, cut lines, etc. are often discovered in surveying along a boundary using traditional methods of surveying. With GPS technology, many surveyors forego the difficult and time consuming walk along the boundary, preferring instead to set up near one corner location, obtain measurements, then drive to a location near the next corner location. As a result, evidence that could help re-establish the position of the original boundary remains undiscovered and ignored. Encroachments along the boundary remain undetected and unresolved. The new technology may increase the speed and efficiency of the survey work but does so at the sake of decreasing the information used and the reliability of the surveyor's opinion.

PROBLEMS UNDETECTED



Even in the hands of a surveyor knowledgeable about the rules of construction and geodesy, GPS causes problems — although ethics no doubt requires the problems be revealed rather than put aside. Consider the diagram showing a small lot that was meant to be bounded on a municipal boundary. In the past, a surveyor creating the lot or retracing the lot should have established the lot's easterly boundary by locating the two ends of the municipal boundary and fixing the lot boundary to coincide with the municipal boundary. However, economics and the errors resulting from traversing long distances often precluded or forced the surveyor to make certain assumptions regarding the position of the municipal boundary (e.g., the existing fence line was on the municipal boundary). The surveyor then located the lot boundary based on these assumptions. Even with the knowledge that such assumptions were often tenuous at best, the surveyor took great comfort from knowing that a subsequent surveyor was no more likely or able to retrace the municipal boundary than the earlier surveyor so any problems would likely remain undetected and undiscovered. With the advent and proliferation of GPS, the situation changes drastically. Previously it would have taken days to traverse between the stones and locate the municipal boundary. Now, the municipal boundary can be located relatively precisely in a matter of hours by occupying the stone corners with GPS receivers. Surveyors that were relatively secure in the knowledge that any errors would likely remain undetected until long after their demise are suddenly faced with the possibility that their errors will be revealed during the next survey of the area — either by their own subsequent work using GPS technology or the work of a competitor using GPS technology.

ADVANTAGES OF GPS

The results of the discussion so far begs the question why use GPS in boundary retracement? GPS appears to pose problems in the hands of the layperson

and the surveyor alike in retracing boundaries. The fact is that GPS can be used to great advantage in boundary retracement by knowledgeable surveyors. It provides an efficient means of locating the position of evidence within a relative or absolute geometric framework — especially if the evidence is separated by long distances or terrain difficult to traverse. Without question, it can provide precise coordinates of properly re-established corners or in fixing the position of new corners in a subdivision. The publication of precise coordinate values (with datum) will provide the future surveyor with a credible piece of evidence to locate the former position of a corner long after the original monument or its replacement have disappeared. Consequently, while a compass and chain may be the best tools to locate the original boundaries, the GPS receiver may be the best tool to tie boundary evidence into a geometric framework and memorialize the location of corners for future recovery. The acceptability and credibility of GPS measurements in boundary retracement will increase as more boundaries are set by the use of precise GPS measurements or later memorialized by GPS measurements. Put in other words, when the tool of the original surveyor is a GPS receiver, the GPS receiver in the hands of the retracement surveyor will be accorded great weight in re-establishing the boundary set by the GPS technology.

CONCLUSION

In conclusion, the proliferation of GPS technology if not used properly can cause problems and errors in retracing boundaries. The technology must be combined in conjunction with a thorough knowledge of the limitations of earlier surveys and the rules of construction. The ease of GPS should not detract from the surveyor's responsibility to search for and retrace the original surveyor's footsteps.

GPS has many advantages for the retracing surveyor. GPS technology allows measurements to be gathered relatively quickly in a short time. Consequently, evidence can be tied into a geometric framework with much less effort. Old boundaries (once properly reestablished) and new boundaries can be defined more precisely and faster by using GPS technology.

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