A Comparison of Methods for Reestablishing Lost Corners of Irregular Parcels

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Abstract: Surveyors confronted with the need to reestablish lost corners along the boundaries of irregular parcels have a variety of methods at their disposal for accomplishing this task. Six methods are examined and applied to a hypothetical scenario. Numerical results are tabulated for a comparison of the methods.

Introduction: A lost corner is defined as a point of a survey whose position cannot be determined by the original monument or by acceptable evidence as to where the original monument was. (Brown, et al, 1995). After exhausting all possibilities of recovering a corner location and making the determination that a corner is lost, the surveyor must often determine how to reestablish the corner position in order to monument said position for a client. Should the lost corner be a lot corner along the exterior of a block, the procedure for reestablishing the corner position is relatively straightforward – apportionment based upon street frontage. A lost corner along the exterior of a USPLSS section is also reestablished in accordance with prescribed proportionate measure techniques.

The determination that a corner is lost along an irregular boundary, such as that shown in Figure 1, presents the surveyor with a challenging reestablishment problem. The retracement surveyor's duty is to identify the original location of a corner – where the original surveyor originally established the corner, not where the original surveyor should have established the corner.

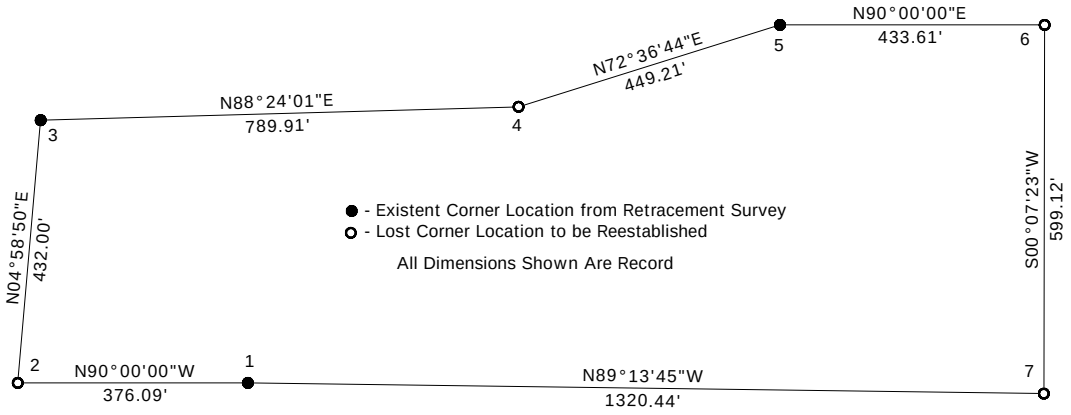

Figure 1. Record Survey Map

The retracement surveyor is somewhat "hamstrung" when a corner is determined to be lost in that he no longer has any evidence of where the corner was originally located, except for a legal description or map specifying the location of the lost corner with respect to other corners along the boundary. With no other evidence at his disposal, the surveyor must use this record evidence to ascertain the original corner position. It is assumed for this discussion that the surveyor has record direction and distance from existent corner positions to the lost corner(s). It will also be assumed that the geometric closure of the record courses is acceptable.

Reestablishment Methods: Six methods of reestablishing lost corners for irregular parcels have been identified. These are described in the following paragraphs.

1. Record Angles and Distances – The retracement surveyor may choose to use the record directions (bearings or azimuths) contained within the description or map to compute record angles. The record angles may then be used with the record distances to reestablish the lost corner positions. This method may be seen as somewhat arbitrary in that it is dependent on the surveyor's choice of existent corners to use as a basis for the reestablishment. Two existent corners must be chosen in order to use the record angle.

Refer to the lost corner identified as 4 in Figure 1. Using this method, corner 4 would logically be reestablished from either corner 3 or 5 (both existent). But existent corner 1 could also be chosen! How is the surveyor to choose? Once a choice is made, which of the other existent corners would be chosen as a basis for the record angle? The reestablished position of corner 4 is dependent on the choice of existent corners.

2. Record Angles – This method again requires the surveyor to compute record angles from the record directions. The record angles are then used to compute directions, based upon the positions of two existent corners, from which the lost corner position is determined by the intersection of two lines. This "line-line" intersection technique may be better known by some surveyors as a "bearing-bearing" or "direction-direction" intersection.

The record angle method could certainly be implemented to reestablish lost corners 4 and 2 in Figure 1. To reestablish corner 4 the surveyor would logically choose adjacent existent corners 3 and 5 from which to run the intersecting lines. A line connecting corners 3 and 5 would likely be chosen as the basis for computing the direction of the intersecting lines using the record angles. Existent corners 1 and 3 would be chosen to reestablish lost corner 2.

Could this method be used to reestablish lost corners 6 and 7? It could if record angles from existent corners 1 and 5 were computed to the two lost corners. But would the "average" surveyor do this? It would seem that application of this technique would be acceptable to most surveyors to reestablish corners 2 and 4 but not acceptable to reestablish corners 6 and 7.

3. Record Distances – The retracement surveyor may choose to use record distances to reestablish lost corners from two existent corners by intersecting circles having radii equal to the respective record distances. This "circle-circle" intersection technique is also known as a "distance-distance" intersection. Like the record angle method, the record distance method would likely be acceptable to more surveyors when the lost corner is located adjacent to two existent corners (e.g., corners 2 and 4) than when two or more lost corners are adjacent to one another (e.g., corners 6 and 7).

4. BLM Manual Sec. 5-43 – The 1973 edition of the *Manual of Instructions for the Survey of the Public Lands of the United States* (Manual) describes a method used to reestablish angle points of nonriparian meaner lines in section 5-43. This method of reestablishing points along an irregular boundary may be used by the retracement surveyor. The method is a compass rule adjustment whereby the closing error between an existent corner position and the corresponding record corner position is apportioned along the boundary lines in accordance with their record lengths from another existent corner. This method would be used three times (between existent corners 1 and 3, 3 and 5, and 5 and 1) to compute the lost corner positions shown in Figure 1.

5. BLM Manual Sec. 5-44 – This method, also contained in the 1973 Manual, is presented as a method for adjusting grant boundaries. The method consists of a rotation and a scale factor. The line connecting the retracement positions of two existent corners is compared with the line connecting the record positions of the same two corners. The difference in direction between the retracement and record connecting lines is used as a rotation angle which is applied to each record course in order to yield the retracement course. This method preserves the record angles between the courses.

A scale factor is applied to each of the record distances in order to ascertain the retracement distances along the boundary. The scale factor is the ratio of the retracement connecting line distance to the record connecting line distance. Like the previous method, this method must be applied between each pair of existent corners where lost corners are present.

6. Four Parameter Transformation – Greenfeld (1996) describes the application of a weighted two-dimensional conformal coordinate transformation in the reestablishment of lost corners. This method provides the "best fit", in a least squares sense, between record positions and retracement positions. It is an unbiased technique that favors neither direction nor distance.

The surveyor is required to compute four transformation parameters to be used to transform the record position of lost corners into retracement positions. The transformation parameters required are a rotation angle, two translation distances and a scale factor. Only one set of transformation parameters need be computed for the scenario depicted in Figure 1.

This technique, virtually unknown among land surveyors, is a powerful tool for determining the positions of lost corners. There are some scenarios where it represents the only logical method of reestablishing lost corners. For instance, a lost interior corner in a subdivision of irregular lots can be reestablished using this method which takes into account the retracement positions of all existent corners. All other methods described in this paper use two existent corners only. This method also has the advantage of allowing the surveyor to "weight" existent corner positions.

Statutory Considerations: Most compilations of state statutes will contain a statute concerning the interpretation of conflicting deed (description) elements. These statutes typically specify the hierarchy of deed elements in the event of conflict between elements of a legal description. Such a statute may specify that monuments control over angles (direction), angles control over lines (distances), and both angles and lines control over surfaces (area). Some surveyors may be tempted to apply such a statute to the reestablishment of lost corners. This could occur if a surveyor used the given hierarchy to argue that the record angle method must be used to reestablish a lost corner. Such application of the statute would be invalid since the principle for which the statute was written (i.e., conflicting deed elements) is not present.

Numerical Comparison: Assume that the retracement survey yielded the following coordinates for the existent corners:

Corner	N (ft.)	E (ft.)
1	9385.073	8831.716
3	9888.102	8590.072
5	9773.809	9828.610

The last five methods for reestablishing lost corners were applied to the scenario shown in Figure 1. Due to the arbitrary nature of the first method, it was not used. Results were compiled in Table 1 as interior angles and distances. Differences between reestablished values and record values are presented in Table 2. This allows for ease of comparison between the various methods. Methods two (record angles) and three (record distances) were only applied to the reestablishment of a single lost corner (corners 2 and 4) between two existent corners.

Method two preserves record angles at reestablished corners but not at existent corners. Method three preserves record distances between existent and reestablished corners. Methods four and six preserve neither record angles nor record distances while method five preserves record angles at reestablished corners. Methods two and five provide similar results due to the fact that record angles are preserved at reestablished corners in both methods.

Table 1.
Comparison of Interior Angles and Distances

Corner	Record	Method of Lost Corner Reestablishment				
		2	3	4	5	6
		Line-Line Intersection	Cir.-Cir. Intersection	BLM Sec. 5-43	BLM Sec. 5-44	4-Param. Transfo.
1	180°46’15”	-	-	180°47’26”	180°46’21”	180°46’48”
	384.09’	383.87’	384.09’	383.96’	383.87’	383.91’
2	85°01’10”	85°01’10”	84°57’35”	84°59’12”	85°01’10”	85°00’19”
	440.00’	439.75’	440.00’	439.92’	439.75’	439.83’
3	96°34’49”	96°35’15”	96°32’03”	96°35’46”	96°35’16”	96°35’33”
	797.91’	797.70’	797.91’	797.72’	797.71’	797.67’
4	195°47’17”	195°47’17”	196°00’23”	195°47’31”	195°47’17”	195°47’03”
	457.21’	457.11’	457.21’	457.10’	457.10’	457.14’
5	162°36’44”	-	-	162°37’10”	162°36’11”	162°36’29”
	441.61’	-	-	441.62’	441.54’	441.46’
6	89°52’37”	-	-	89°52’14”	89°52’37”	89°52’47”
	615.12’	-	-	615.05’	615.02’	614.97’
7	89°21’08”	-	-	89°20’41”	89°21’08”	89°21’00”
	1328.44’	-	-	1328.42’	1328.21’	1328.19’
1						

Table 2
Differences in Interior Angles and Distances
(Reestablished – Record)

Corner	Record	Method of Lost Corner Reestablishment				
		2	3	4	5	6
		Line-Line Intersection	Cir.-Cir. Intersection	BLM Sec. 5-43	BLM Sec. 5-44	4-Param. Transfo.
1	180°46’15”	-	-	0°01’11”	0°00’06”	0°00’33”
	384.09’	-0.22’	0.00’	-0.13’	-0.22’	-0.18’
2	85°01’10”	0°00’00”	-0°03’35”	-0°01’58”	0°00’00”	-0°00’51”
	440.00’	-0.25’	0.00’	-0.08’	-0.25’	-0.17’
3	96°34’49”	0°00’26”	-0°02’46”	0°00’57”	0°00’27”	0°00’44”
	797.91’	-0.21’	0.00’	-0.19’	-0.20’	-0.24’
4	195°47’17”	0°00’00”	0°13’06”	0°00’14”	0°00’00”	-0°00’14”
	457.21’	-0.10’	457.21’	-0.11’	-0.11’	-0.07’
5	162°36’44”	-	-	0°00’26”	-0°00’33”	-0°00’15”
	441.61’	-	-	0.01’	-0.07’	-0.15’
6	89°52’37”	-	-	-0°00’23”	0°00’00”	0°00’10”
	615.12’	-	-	-0.07’	-0.10’	-0.15’
7	89°21’08”	-	-	-0°00’27”	0°00’00”	-0°00’08”
	1328.44’	-	-	-0.02’	-0.23’	-0.25’
1						

Conclusions: There is no one method that stands out as being superior for the scenario presented. The surveyor must rely on his professional judgement to select a lost corner reestablishment method. A different scenario may result in the choice of a different method.

The surveyor may desire a method that can be defended in court. This may require that the method can be explained with relative ease to a judge. The court may also desire a method that it senses to be equitable and unbiased.

The method chosen may also be influenced by physical evidence on the ground. Choosing a method that best matches lines of occupation or other non-record evidence may be desirable.

References:

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